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169.1444

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)
ERNEST YIU CHEONG WAN) : Examiner: Not Yet Assigned
Application No.: 09/392,550) : Group Art Unit: NYA
Filed: September 9, 1999) :
For: HYPERPRINT METHOD AND) :
APPARATUS) : October 1, 1999

Assistant Commissioner for Patents
Washington, D.C. 20231

CLAIM TO PRIORITY

Sir:

Applicant hereby claims priority under the
International Convention and all rights to which he is
entitled under 35 U.S.C. § 119 based upon the following
Australian Priority Applications:

PP 5955, filed September 15, 1998; and

PQ 0282, filed May 10, 1999.

Certified copies of the priority documents are
enclosed.

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Applicant's undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address given below.

Respectfully submitted,


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**Patent Office
Canberra**

I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PP 5955 for a patent by CANON KABUSHIKI KAISHA filed on 15 September 1998.

WITNESS my hand this
Fourteenth day of September 1999

A handwritten signature in black ink, appearing to be "Kim Marshall".

**KIM MARSHALL
MANAGER EXAMINATION SUPPORT
AND SALES**



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ORIGINAL

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED:

Hyperprint Method and Apparatus

Name and Address
of Applicant: Canon Kabushiki Kaisha, incorporated in Japan, of 30-2,
Shimomaruko 3-chome, Ohta-ku, Tokyo, 146, JAPAN

Name of Inventor: Ernest Yiu Cheong Wan

This invention is best described in the following statement:

HYPERPRINT METHOD AND APPARATUS

Field of the Invention

The present invention relates to preparing hypermedia documents that retain their hyperlinks in the printed copy, and more particularly to an authoring system for providing a near-optimal assignment of physical links to hyperlinks.

Background

Hypermedia documents are computer-based electronic documents that contain text, graphics, audio and video on pages that are connected by navigational links. The navigational links, often referred to as the hyperlinks, permit non-sequential or non-linear traversal of the document by the readers. A well-known source of hypermedia documents is the so-called World Wide Web (WWW) or simply, "the Web".

Hypermedia documents allow multiple simultaneous views and efficient non-linear exploration of information that are not possible with conventional printed documents such as books. On the other hand, unlike books, the absence of an obvious linear structure and a sense of physical orientation in hypermedia documents allows users to become easily lost in the hyperspace of the document.

Although hypermedia documents may be printed, the hyperlinking functionality is typically lost in the printed copy. Most hypermedia documents, especially those on the Web are intended for viewing on the screen and designed to exploit the hyperlinking functionality. As a result, readability also suffers with the loss of the hyperlinks. For instance, removing the hyperlink to the definition of an unfamiliar term may make a description unclear to the readers.

Australian Patent Application No. 83194/98 filed 7 September 1998 (Attorney Ref: 432345 CFP0954AU MMedia02) claiming priority from Australian Patent Application No. PO9045 filed 8 September 1997 discloses a method for forming hypermedia documents that retain their electronic hyperlinks as physical hyperlinks within the printed reproduction of the document. The method associates the hyperlinks with cut-outs or tabs on the edges of the pages and lines or other indicia printed onto the page. To traverse a hyperlink, the reader follows the indicia, places a finger or

thumb within the cut-out, locates the first uncut page surface below the cut-out and opens that page.

As the number of hyperlinks increase, it is apparent that the number of cut-outs and thus hyperlinks, is limited by the physical dimensions of the pages. It is
5 therefore desirable to reuse the cut-outs for multiple hyperlinks and optimise their assignment.

Summary of the Invention

In accordance with the present invention there is disclosed a method of creating a document suitable for hard copy reproduction, said method comprising the steps of:

- 10 (a) receiving information from at least one source, said information including a plurality of referential links establishing corresponding referential paths between components of said information;
- (b) defining a physical structure of said document sufficient to reproduce said information;
- 15 (c) defining a plurality of document links corresponding to said referential links;
- (d) assigning a user interpretable functional link to each said document link; and
- (e) optimising a number of said user interpretable functional links by
20 assigning appropriate plural ones of said document links to individual ones of said functional links.

In accordance with the present invention there is disclosed an authoring system for the creation of a linear document having non-linear referential links, said system including:

- 25 means for specifying a linear document structure and the hyperlinks of a hypermedia document;
- means for associating said hyperlinks with physical links able to be formed in pages of said document;

means for modelling each said physical link using a one-dimensional vector;
and
optimising an assignment of the physical links to one or more of said
hyperlinks.

5

Brief Description of the Drawings

A preferred embodiment of the present invention will now be described with
reference to the drawings in which:

Fig. 1 is an example of a typical electronic hypermedia document obtained
from the World Wide Web;

10

Fig. 2 shows an electronic hard-copy reproducible hypermedia document
constructed from that of Fig. 1 using the method described by the aforementioned
Australian Patent Application;

Fig. 3 shows the printed version of the electronic hypermedia document of
Fig. 2;

15

Fig. 4 is a summary of graphical notations of physical hyperlinks used in the
preferred embodiment;

Fig. 5 is a flow diagram of the preferred embodiment of the authoring system
that creates hypermedia document templates or hypermedia documents with physical
hyperlinks;

20

Fig. 6 provides an example of a restaurant's guide created using the authoring
system of Fig. 5;

Fig. 7 is a diagrammatic representation of the cut-out tabs of the restaurant's
guide of Fig. 6;

Figs. 8A and 8B illustrate optimisation of hyperlinks within a page; and

25

Fig. 9 is a block diagram of a general purpose computer upon which the
preferred embodiment of the present invention can be practiced;

Detailed Description

The preferred embodiment of the present invention is described as a computer
application program hosted on the Windows™ operating system developed by Microsoft

Corporation. However, those skilled in the art will recognise that the described embodiment may can be implemented on computer systems hosted by other operating systems. For example, the preferred embodiment can be performed on computer systems running UNIX™, or OS/2™. The application program has a user interface
5 which includes menu items and controls that respond to mouse and keyboard operations. The application program has the ability to transmit data to one or more printers either directly connected to a host computer or accessed over a network. The application program also has the ability to transmit and receive data to a connected digital communications network (for example the "Internet").

10 The preferred embodiment of the invention can be practised using a conventional general-purpose (host) computer system, such as the computer system 40 shown in Fig. 9, wherein the application program discussed above and to be described with reference to the other drawings is implemented as software executed on the computer system 40. The computer system 40 comprises a computer module 41, input
15 devices such as a keyboard 42 and mouse 43, output devices including a printer 13 and a display device 11. A Modulator-Demodulator (Modem) transceiver device 52 is used by the computer module 41 for communicating to and from a computer network, for example connectable via a telephone line or other functional medium. The modem 52 can be used to obtain access to the Internet, and other network systems.

20 The computer module 41 typically includes at least one processor unit 45, a memory unit 46, for example formed from semiconductor random access memory (RAM) and read only memory (ROM), input/output (I/O) interfaces including a video interface 47, and an I/O interface 48 for the keyboard 42 a mouse 43 and optionally a joystick (not illustrated). A storage device 49 is provided and typically includes a hard
25 disk drive 53 and a floppy disk drive 54. A CD-ROM drive 55 is typically provided as a non-volatile source of data. The components 45 to 49 and 53 to 55 of the computer module 41, typically communicate via an interconnected bus 50 and in a manner which results in a conventional mode of operation of the computer system 40 known to those in the relevant art. Examples of computers on which the embodiments can be practised

include IBM-PC/ATs and compatibles, Sun Sparcstations or alike computer systems. Typically, the application program of the preferred embodiment is resident on a hard disk drive 53 and read and controlled using the processor 45. Intermediate storage of the program and the print list and any data fetched from the network may be accomplished using the semiconductor memory 46, possibly in concert with the hard disk drive 53. In some instances, the application program may be supplied to the user encoded on a CD-ROM or floppy disk, or alternatively could be read by the user from the network via the modem device 52.

Referring to Fig. 1, an electronic multi-page hypermedia document 100 is shown which illustrates a typical layout of multi-media content spread over pages 120,122,124 which also include hyperlinks 140,142. It will be appreciated that these are but some of the pages and hyperlinks in document 100. Navigating through the pages is accomplished by traversing the hyperlinks initiated by a signal such as a mouse-click or a finger-touch on the hyperlink anchors. For instance, selecting an anchor 160 of hyperlink 140 will cause page 122 to be displayed, whilst selecting an anchor 162 of hyperlink 142 will cause page 124 to be displayed. The function of the hyperlinks are to be retained in the printed copy of the document.

Fig. 2 shows an equivalent electronic multi-page hard copy reproducible hypermedia document 300 constructed from the document 100 in accordance with the method described in the aforementioned Australian Patent Application, the disclosure of which is annexed hereto and marked as Appendix 1, and which allows the converted document to retain its hyperlinks in the printed copy. The content pages of the document 100 are reformatted to satisfy the physical constraints of the print media. In the example shown, pages 120 and 124 of the document 100 are laid out on the odd-numbered pages 320 and 324 respectively, while page 122 of document 100 is split into an even-numbered page 322 and an odd-numbered page 323. Fig. 3 shows the printed copy 500 of the document 300, wherein the electronics pages 320 and 322 of the document 300 are printed on the two sides of the physical page 520, and the electronics

pages 323 and 324 are printed on the odd-numbered side of the physical pages 523 and 524 respectively.

In this example, the electronic hyperlinks of the document 100 are associated with cut-outs on the edges of the pages. To traverse a hyperlink, the reader places a finger or thumb within the cut-out, locates the first uncut page surface below the cut-out and opens that page. In the document 300, the hyperlinks 140,142 of the document 100 become associated with tabs 340 and 342 respectively which form cut-outs 540 and 542 in the printed copy 500 of Fig. 3 retaining their hyperlinking functionality. On page 320 of the document 300, selecting the tab 340 causes the page 322 to be displayed in a one-page mode and both pages 322 and 323 to be displayed in a two-page mode. Moreover, on page 320, selecting the tab 342 causes page 324 to be displayed in one-page display mode and page 324 and its opposite page to be displayed in a two-page display mode. Note that tab 342 is not active on page 323 as indicated, in this particular implementation, by the absence of a label.

Due to the limited amount of space on the edges of the printed copy, it is possible that some hyperlinks in an electronic hypermedia document cannot be retained in its printed copy as cut-out tabs. While the number of cut-out tabs that can be made along the edges is limited, under certain conditions, it is possible to assign multiple hyperlinks to one cut-out tab. Moreover, related hyperlinks can be grouped to form a set of nested tabs of progressive size along a single axis, for instance, 344 in document 300 and 544 in the corresponding copy 500. When using a set of nested tabs, the user selects which hyperlink to traverse by simply moving the thumb or finger slightly to grasp the desired size of the cut-out.

The preferred embodiment optimises the assignment of the cut-outs and other physical hyperlinks. More specifically, the preferred embodiment provides a mathematical model for describing hyperlinks and cut-out tabs and uses the model to optimise the number of tabs and axes that are required for implementing a given set of hyperlinks. The preferred embodiment will be explained using a particular authoring system that creates hypermedia documents with physical hyperlinks. It will be

appreciated that the present invention can be used in other authoring processes as well as in processes that convert existing electronic hypermedia documents to a format that supports physical hyperlinks.

5 A physical hyperlink from an anchor (or hot-spot) on page S to a target on page T can be represented by a data structure comprising of the 1-dimensional vector \overline{ST} describing the path traversed by the hyperlink and the location of the target page, that is, the page number of T. Since hyperlinks are typically implemented physically as cut-out tabs and can be in either a forward or a backward direction, bi-dimensional vectors are involved. The same basic data structure is used to represent the cut-out tabs. Each
10 physical hyperlink in the document is typically associated with one cut-out tab. However, a number of hyperlinks may be able to share one cut-out tab. The preferred embodiment involves a process that starts with a set of cut-out tabs each representing one hyperlink of the hypermedia document. The set of cut-out tabs is then gradually reduced by combining cut-out tabs which can serve multiple hyperlinks.

15 Other physical attributes such as the size of the tabs and the page, as well as certain system parameters such as the edges to be used for tabs, the maximum number of tabs that can be nested along a single axis and the density of the tabs along an edge are required when optimizing the placement of the cut-out tabs and are typically retained in a tab data structure. Additional attributes such as the location of the tabs on
20 an edge, the shape of the tabs, the colors and labels used by the tabs, etc. are required when producing the tabs. Default values or user's inputs can be used for the value of those attributes that are not set by the optimization process. The author should be allowed to examine the results of the optimization process and make adjustments as required.

25 A tab running from S to T has to pass through all the pages in between and is visible, although not necessarily required by those pages. Appropriate presentational style may be used to distinguish an inactive tab from an active tab, for instance by removing or greying out the label of a tab when it has no associated hyperlink. An array is added to the data structure of the cut-out tab to store the status of the tab for

the intermediate pages. In case the tab is shared by multiple hyperlinks, a second array is used to store the labels of the tab for the intermediate pages. Hereafter, depending on the context, the notation **ST** is used to denote a hyperlink or a cut-out tab from page **S** to page **T**. In addition, Fig. 4 shows graphical notations used to depict the cut-out tabs diagrammatically. The graphical notations can also be used in the graphical user interface (GUI) of an authoring system or editing tool to visualize the assignment and the physical arrangement of the tabs.

Fig. 5 shows the preferred embodiment of a system 600 for authoring hypermedia documents with physical hyperlinks. The system 600 optimises the assignment of hyperlinks to cut-out tabs. Fig. 6 shows, in two-page display mode, the representative pages of a hyperlinked restaurant's guide 800 created by the system 600. Fig. 7 shows the diagrammatic representation of the cut-out tabs of the restaurant's guide 800. The restaurant's guide will be used as an example in the description of the system.

Fig. 6 illustrates the starting page of the main sections of the restaurant's guide 800. The sections are defined as indicated in step 610 of Fig. 5 which provides the linear structure of the document 800. Each section is a group of related pages and has an associated identifier. The root (or starting) pages of document 800 is denoted as **R**, followed by the restaurant directories **D_i**, for m types of cuisines, where $i=1, \dots, m$. The restaurants are also grouped into sections related to the suburb in which each is located, one for each of the n listed suburbs. Each suburb section has an overview page **S_j** and m cuisine sub-sections **C_{ij}**, $i=1, \dots, m$, one for each of the m cuisines where $1 \leq j \leq n$. In summary, the document 800 has the (linear) structure:

$$\mathbf{R} \mathbf{D}_1 \mathbf{D}_2 \dots \mathbf{D}_m \mathbf{S}_1 \mathbf{C}_{11} \mathbf{C}_{21} \dots \mathbf{C}_{m1} \dots \mathbf{S}_n \mathbf{C}_{1n} \mathbf{C}_{2n} \dots \mathbf{C}_{mn}$$

To allow document 800 to be traversed in a non-linear manner among the various sections, a number of hyperlinks are defined in step 612. Using the graphical notations of Fig. 4, the hyperlinks are denoted as indicated in Table 1. In step 614, each of these hyperlinks is assigned a tab.

TABLE 1

Hyperlinks	Description
$RD_i, i = 1, \dots, m$	from the root page to each cuisine directory
$D_r D_s, r, s = 1, \dots, m, r \neq s$	from each cuisine directory to another cuisine directory
$D_i S_j, i = 1, \dots, m, j = 1, \dots, n$	from each cuisine directory to each suburb section
$S_j D_i, i = 1, \dots, m, j = 1, \dots, n$	from each suburb section to each cuisine directory
$RS_j, j = 1, \dots, n$	from the root page to each suburb section
$S_j C_{ij}, i = 1, \dots, m, j = 1, \dots, n$	from each suburb section to each of its local cuisine sections
$C_{rj} C_{sj}, r, s = 1, \dots, m, r \neq s, j = 1, \dots, n$	from each cuisine section of a suburb to the other cuisine sections of the same suburb
$C_{rj} D_i, r, i = 1, \dots, m, j = 1, \dots, n$	from each cuisine section of a suburb to the cuisine directories

Note that hyperlink definitions can be either "static" or "dynamic". RD_i and $C_{rj}C_{sj}$ are two examples of a "dynamic" hyperlink definition. In the case of RD_i , a hyperlink is generated between the "static" document element **R** and every occurrence of the "dynamic" document element **D**. In the case of $C_{rj}C_{sj}$, a hyperlink is generated between every occurrence of two "dynamic" document elements. In contrast, a "static" hyperlink definition defines a fixed hyperlink between two "static" document elements.

In step 616, the number of tabs is reduced by assigning multiple hyperlinks to some of the tabs. A tab can be used for multiple hyperlinks that ended at the same page as the tab. In fact, a tab **AB** can potentially be used for all hyperlinks starting at section **A** or at a section between **A** and **B** and ended at section **B** provided that the tab is properly labelled on all the pages it passes through and that such use is not confusing to the reader. For instance, tab 910 of Fig. 7 running from **R** to D_m is shared by hyperlinks RD_m and $D_p D_m$ where $p=1, \dots, m-1$. In addition, a tab leading from a page **A** to a page **B** provides an implicit return path from page **B** to page **A**. Hence, the number of tabs can be reduced by merging tab pairs that have their two tabs start on the page at which other tab ends.

In step 618, related tabs are nested to reduce the total number of axes required. Nesting tabs on the same axis allows hyperlinks with different target pages to share the same axis therefore making available edge space for other tabs. However, the overall size of the resulting set of nested tabs is larger than a normal tab. Hence, the saving is not exactly n folds for nesting n tabs. Moreover, indiscriminate nesting of tabs may introduce artificial grouping of otherwise unrelated content and confuse the reader. Hence, a set of nested tabs is preferably used only where a natural or logical relationship exists among the linked materials. Such relationship may be inferred from the structure of the documents. For instance, the set of nested tabs 912 of Fig. 7 are used for assessing the m restaurant directories each for a different cuisine. In this case, the nesting of tabs reduces the number of axes required from m to 1.

Steps 616 and 618 can be fully-automated. However, an editing tool that allows the user to adjust the resulting hyperlinks/cut-out tabs assignment interactively is sometimes desirable.

In step 620, presentational style such as the location, colour, size, shape, etc. of the tabs are defined along with the presentational style of the other elements of the documents such as those of the headers, paragraphs, tables, lists, etc. A number of presentational styles 644 can be defined to allow the document to be presented in different ways.

The structural definitions 642 of the hypermedia document created as a result of steps 610 to 618 and the style definitions 644 created as a result of step 620 can be saved and used as a document template 640 for creating documents of the same type in the future. In the case of the restaurant's guide example of Fig. 6, XML and XSL are used for defining the structure and the style of the document respectively while the hypermedia document 646 is generated in HTML format.

In step 622, content is added either interactively using an editor or from data files using a loader or both. Additional hyperlinks and tabs are generated from the "dynamic" hyperlink definitions. It will be appreciated that all copies of the tabs generated from a "dynamic" hyperlink definition can use the same set of axes. For

instance, in Fig. 7, the RD_i 's use a single set of nested tabs 912 and the $C_{rj}C_{sj}$'s use the same two axes for their nested tabs 914.

After the content is added, new content specific hyperlinks and their associated tabs can be defined if required as indicated in step 624. The number of new tabs can
5 also be reduced using the same methods used in step 616 and 618.

It will be appreciated that the hyperlinks in the resulting hypermedia document 646 are optimally or near-optimally assigned to the cut-out tabs that serve as physical hyperlinks in the printed copy.

Although the forgoing embodiment describes optimising the hyperlinks spread
10 across a number of page using cut-out tabs, the same optimising principles may be applied to individual pages and links on those pages. Fig. 8A shows a traditional arrangement of a hyperlinked page 1000 which includes four hyperlink anchors (ANCHORS 1-4) and two hyperlink destinations, one being a cut-out tab 1002 formed in the page 1000, and the other being a LINKED_COMPONENT printed on the page 1000.
15 As seen, printed hyperlinks 1004 and 1006 (printed lines on the page) directly connect the ANCHOR 1 and ANCHOR 3 respectively to the LINKED_COMPONENT. Similarly, hyperlinks 1008 and 1010 directly connect ANCHOR 2 and ANCHOR 4 respectively to the cut-out tab 1002. It is apparent from Fig. 8A that some amount of optimisation may be made in order to maximise the available space on the page 1000.

20 Fig. 8B shows how the page 1000 may be optimised according to another embodiment. As with the multi-page cut-out cases described above, here hyperlinks that point to the same destination are combined as best possible within the confines of the document to minimise the number of links on the page. As seen in Fig 8B, the printed hyperlinks are altered in their placement on the page with printed
25 hyperlinks 1112 and 1114 from ANCHORS 1 and 3 respectively merging into a hyperlink 1116 which accesses LINKED_COMPONENT. Similarly, hyperlinks 1118 and 1120 from ANCHORS 2 and 4 respectively, merge into a hyperlink 1122 which access the cut-out 1002. In this fashion it is seen that the application of the

optimisation process can reduce the space used by the hyperlinks internally referencing a single page.

Whilst the example of Fig. 8B demonstrated the use of printed lines as hyperlink indicia, other indicia may be used. For example, graphic symbols and the
5 like may substitute for the printed lines to provide to the reader the same referential link that otherwise would have been provided in an electronically linked document.

Annexed hereto and marked as Appendix 2 is a copy of a (yet) unpublished paper co-authored by the present inventor and entitled "Retaining Hyperlinks in Printed Hypermedia Document" which provides further discussion on the various features and
10 aspects of the present invention and its various embodiments.

The foregoing describes only a particular embodiment of the present invention, and modifications and alternatives obvious to those skilled in the art can be practiced within the spirit of the invention. Specific aspects of the invention may now be recited.

Aspects of the Invention

1. A method of creating a document suitable for hard copy reproduction, said method comprising the steps of:

5 (a) receiving information from at least one source, said information including a plurality of referential links establishing corresponding referential paths between components of said information;

(b) defining a physical structure of said document sufficient to reproduce said information;

10 (c) defining a plurality of document links corresponding to said referential links;

(d) assigning a user interpretable functional link to each said document link; and

(e) optimising a number of said user interpretable functional links by
15 assigning appropriate plural ones of said document links to individual ones of said functional links.

1A. A method according paragraph 1 wherein step (e) includes the step of importing said information into said structure to form said document, and applying said
20 optimised links to said document.

2. A method according to paragraph 1 or 1A, wherein said physical structure includes a single page and said functional links include indicia printable onto said page, and appropriate plural ones of said document links are merged to form a single said
25 indicia associated with a component on said page.

3. A method according to paragraph 1, 1A or 2 wherein said physical structure includes plural pages and said functional links include cut-out tabs formed in at least

one of said pages, and appropriate plural ones of said document links refer to a single said cut-out tab.

4. A method according to paragraph 3, wherein at least one said cut-out tab is
5 formed as part of a nest of correspondingly located tabs distributed amongst consecutive ones of said pages.

5. A method according to paragraph 4 further comprising the step of retaining
structure definitions of said document in a template for formatting subsequent
10 documents in a corresponding fashion.

6. A method according to paragraph 4 or 5 further comprising defining a
presentational style to said document and applying said presentational style to said
functional links to distinguish said functional links from said components.

15

7. A method according to paragraph 6 further comprising the step of retaining
said presentational style of said document in a template for formatting subsequent
documents with a corresponding presentational style.

20 8. A method according to paragraph 1 further comprising defining content specific document links and incorporating corresponding functional links into said document.

9. A method according to paragraph 8 wherein said content specific document
25 links are user defined.

10. Apparatus for performing the method of any one of the preceding paragraphs.

11. A computer program product incorporating a computer readable medium having a series of program instructions configured to perform the method of any one of paragraphs 1 to 9.

5 12. An authoring system for the creation of a linear document having non-linear referential links, said system including:

means for specifying a linear document structure and the hyperlinks of a hypermedia document;

means for associating said hyperlinks with physical links able to be formed in
10 pages of said document;

means for modelling each said physical link using a one-dimensional vector;
and

optimising an assignment of the physical links to one or more of said hyperlinks.

15

13. A method of creating a document substantially as described herein with reference to any one of the embodiments as illustrated in the drawings.

14. A document creation system substantially as described herein with reference
20 to any one of the embodiments as illustrated in the drawings.

APPENDIX 1: Australian Patent Application No. _____ (432345 MMedia02)

- 5 APPENDIX 2: Paper entitled "Retaining Hyperlinks in Printed Hypermedia Document" Wan, E.; Robertson, P.

DATED this Sixteenth Day of September 1998

Canon Kabushiki Kaisha

Patent Attorneys for the Applicant

SPRUSON & FERGUSON



Figure 1

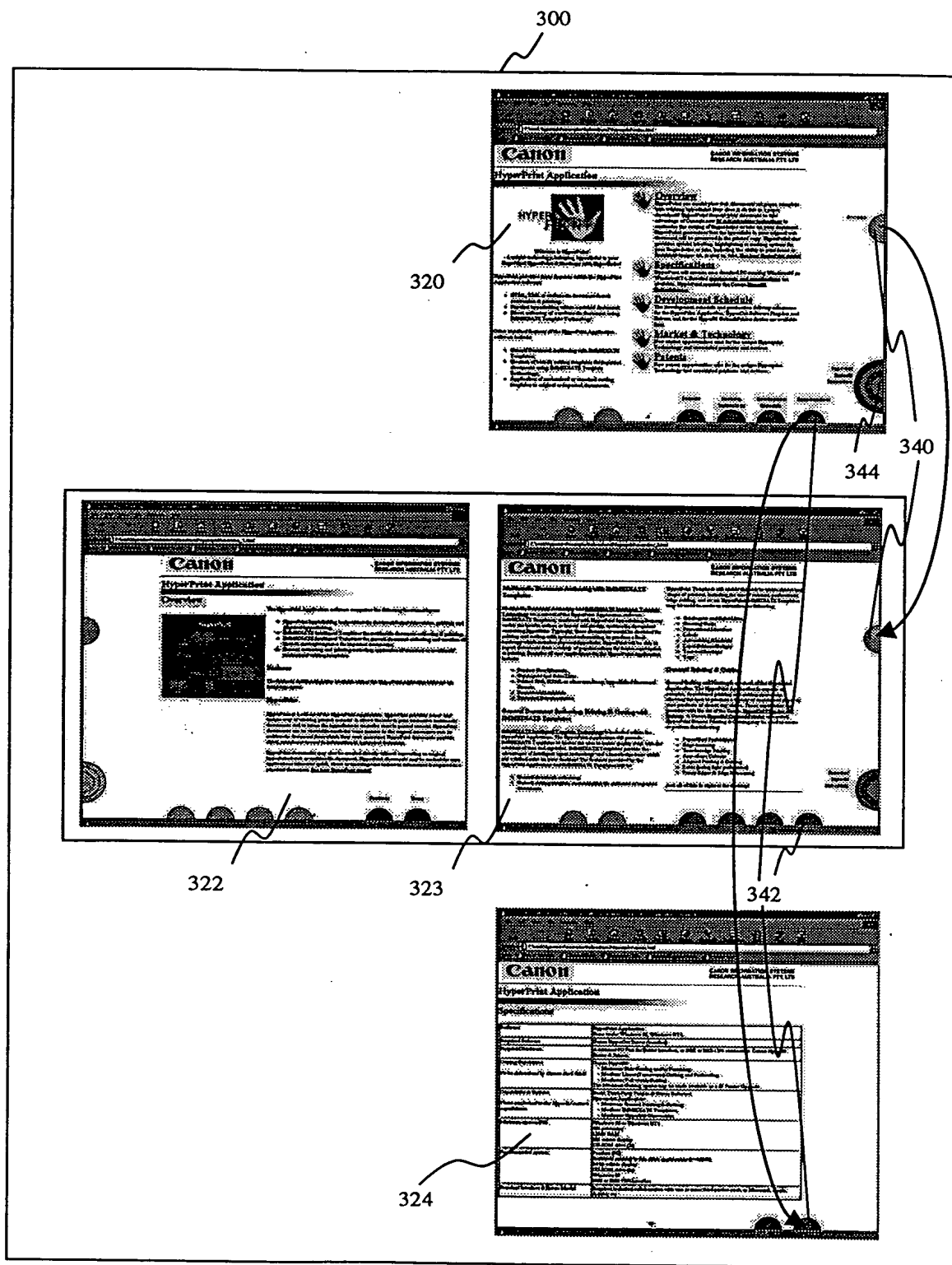


Figure 2

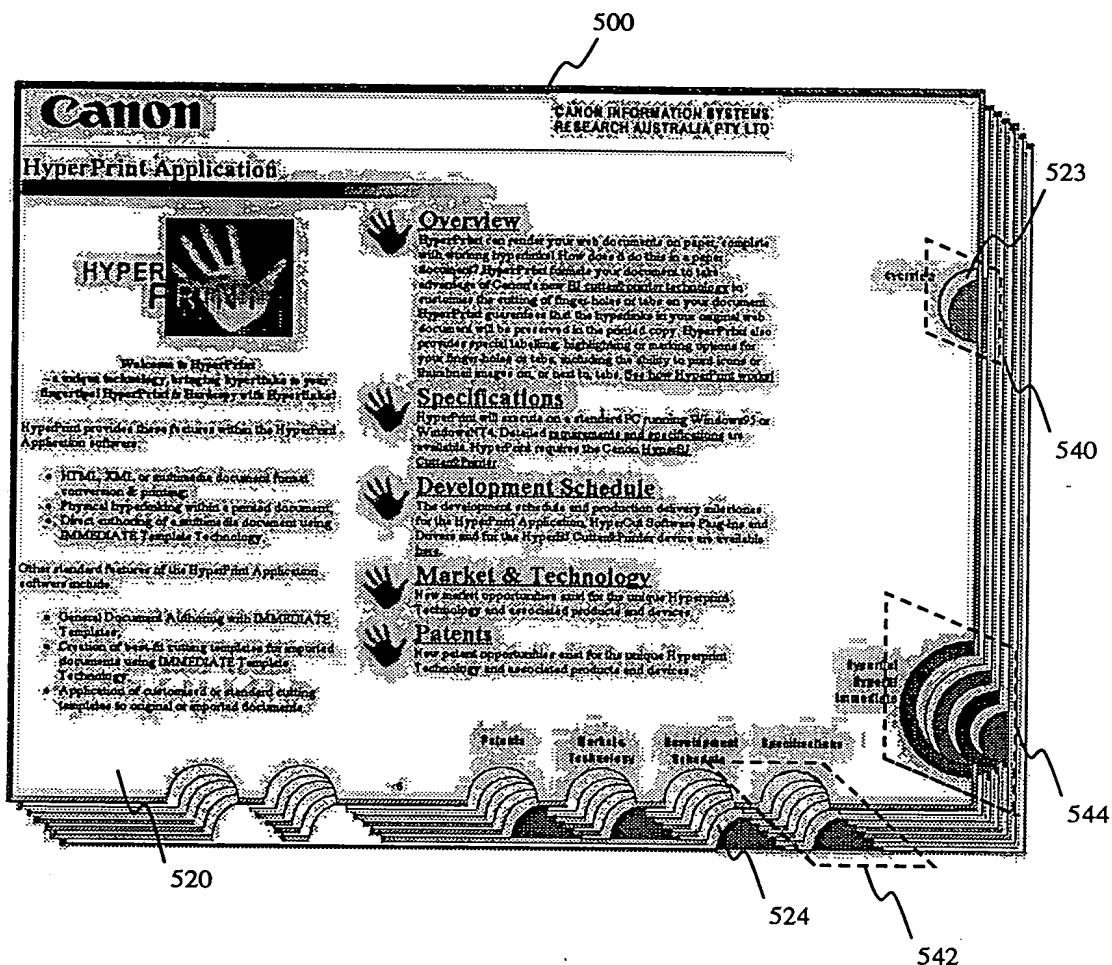


Figure 3


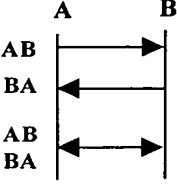
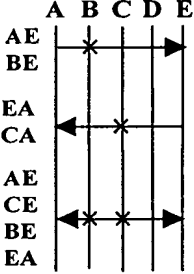
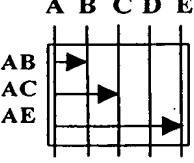
	<p>Section: A vertical bar denotes a section, that is, a set of one or more consecutive pages. The identifiers above the vertical bar denote the end-points of the hyperlinks that start or end at the section, that is, the anchors and targets defined within the section.</p>
	<p>Tab: A cut-out tab is denoted by an arrow. A left pointing arrow represents a forward link and a right pointing arrow represents a backward link. An arrow with arrow head at both ends represents a bi-directional tab that provides both a forward and a backward link. The arrow is labelled. The label indicates the hyperlinks that are associated with the tab. The label has the format ST where S is the identifier of the anchor and T is the identifier of the target.</p>
	<p>Shared tabs: To denote a cut-out tab that is shared by a set of hyperlinks, a cross is placed at the anchor section of each hyperlink except the outermost one along the arrow that represents the tab.</p>
	<p>Nested tabs: A set of arrows enclosed in a rectangular box denotes a set of nested cut-out tabs.</p>

Figure. 4

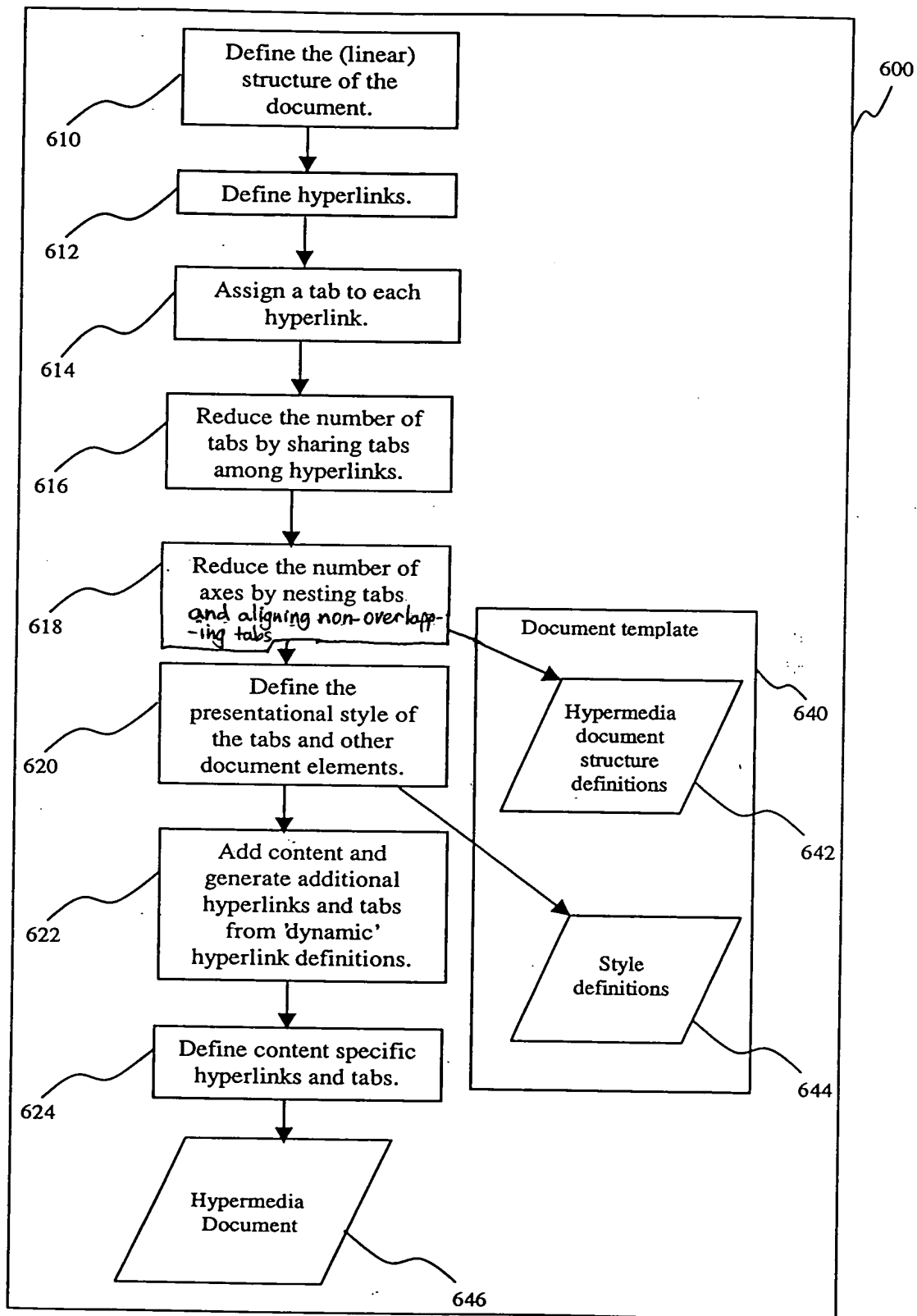


Figure 5

6/4

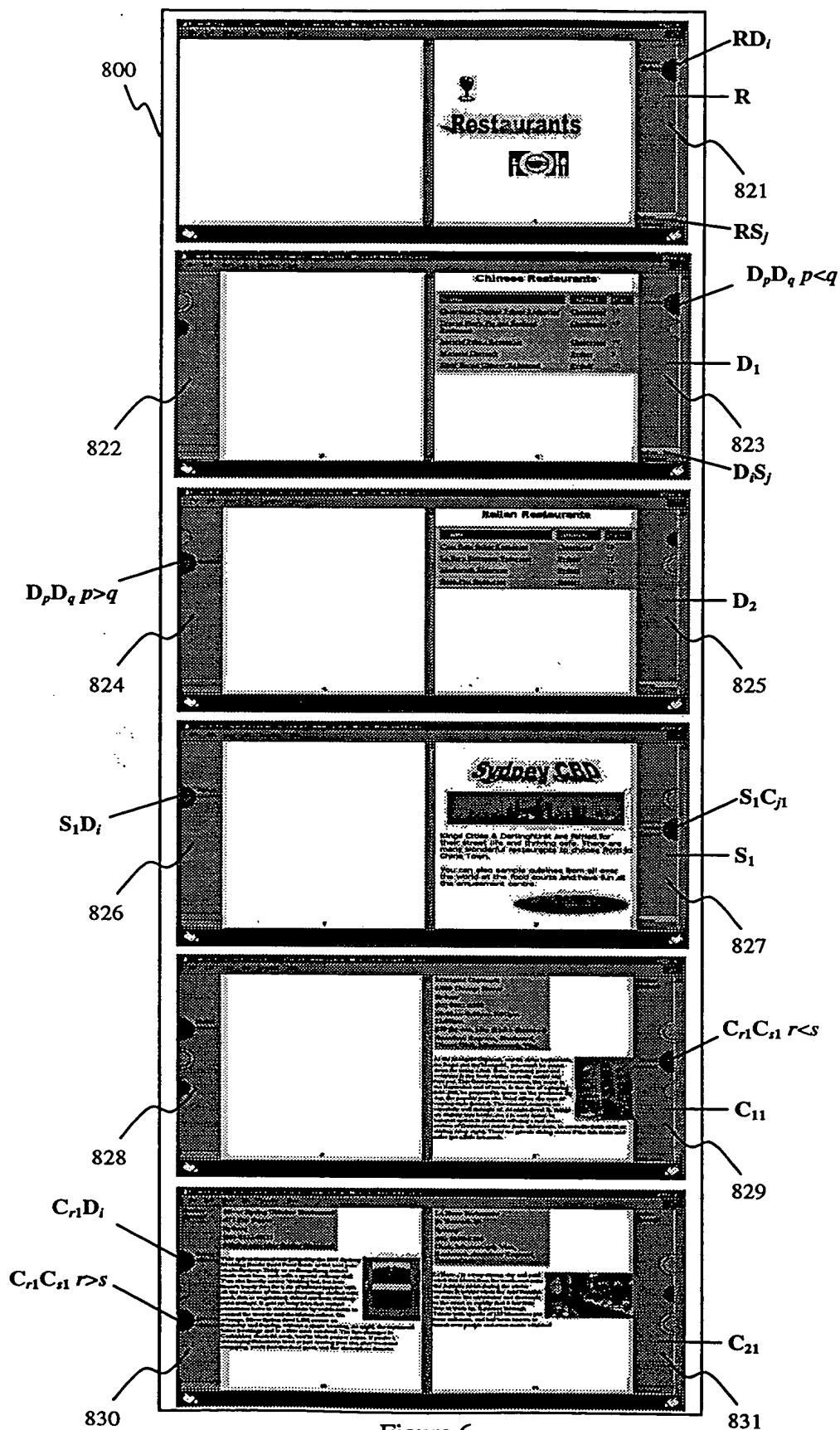


Figure 6

7/1

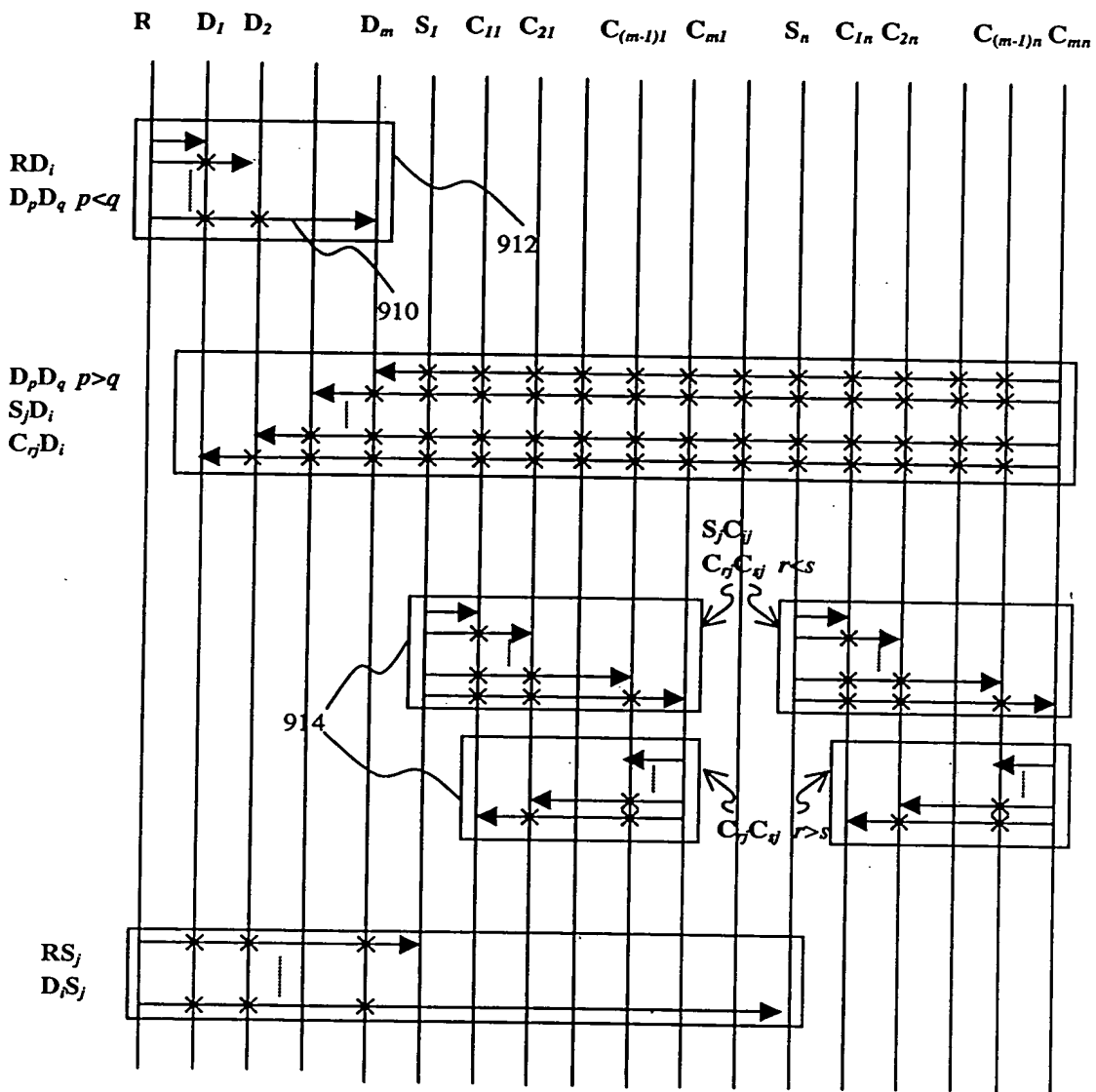


Figure 7

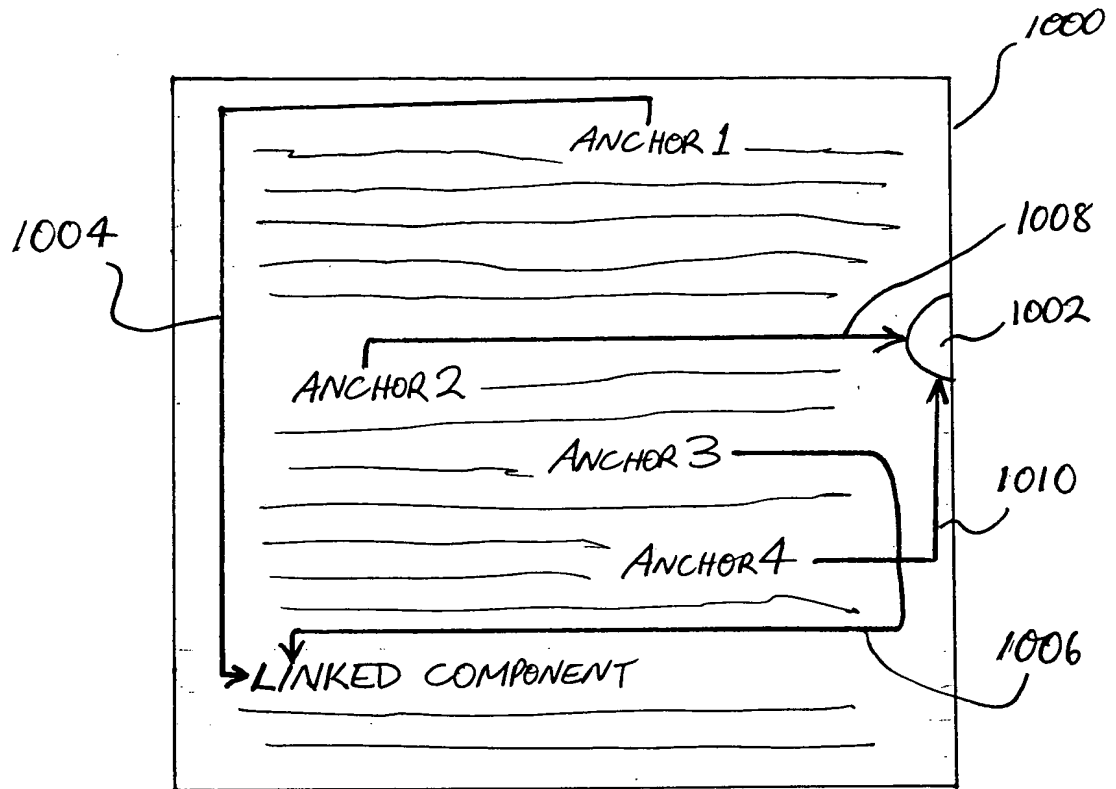


FIG. 8A

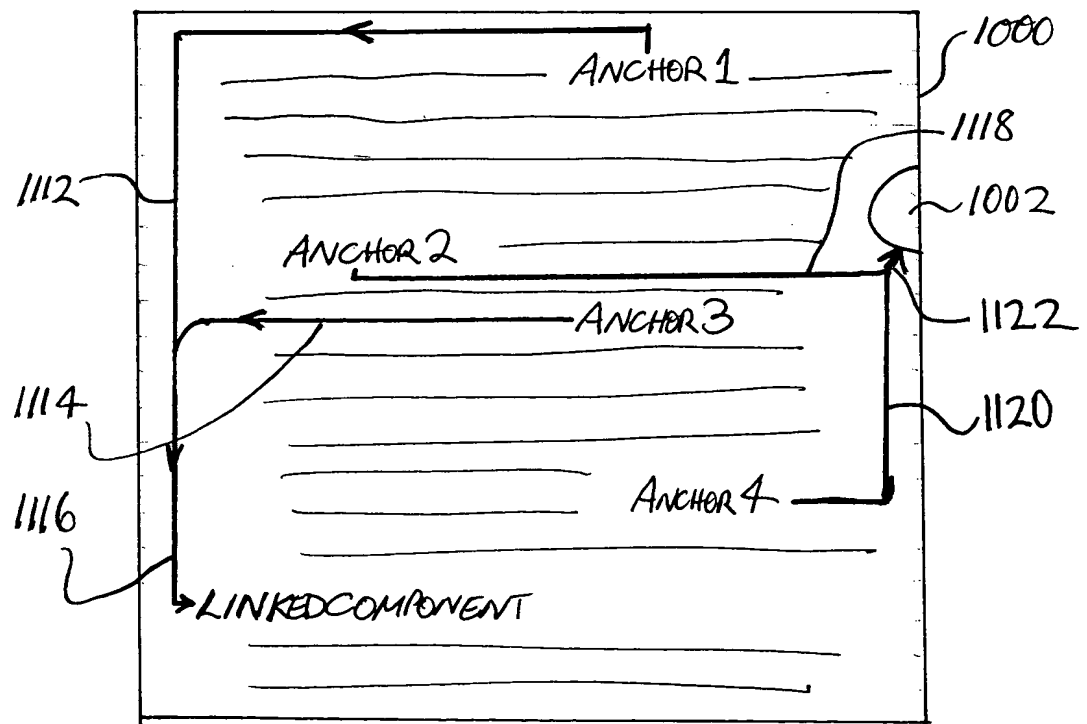


FIG. 8B

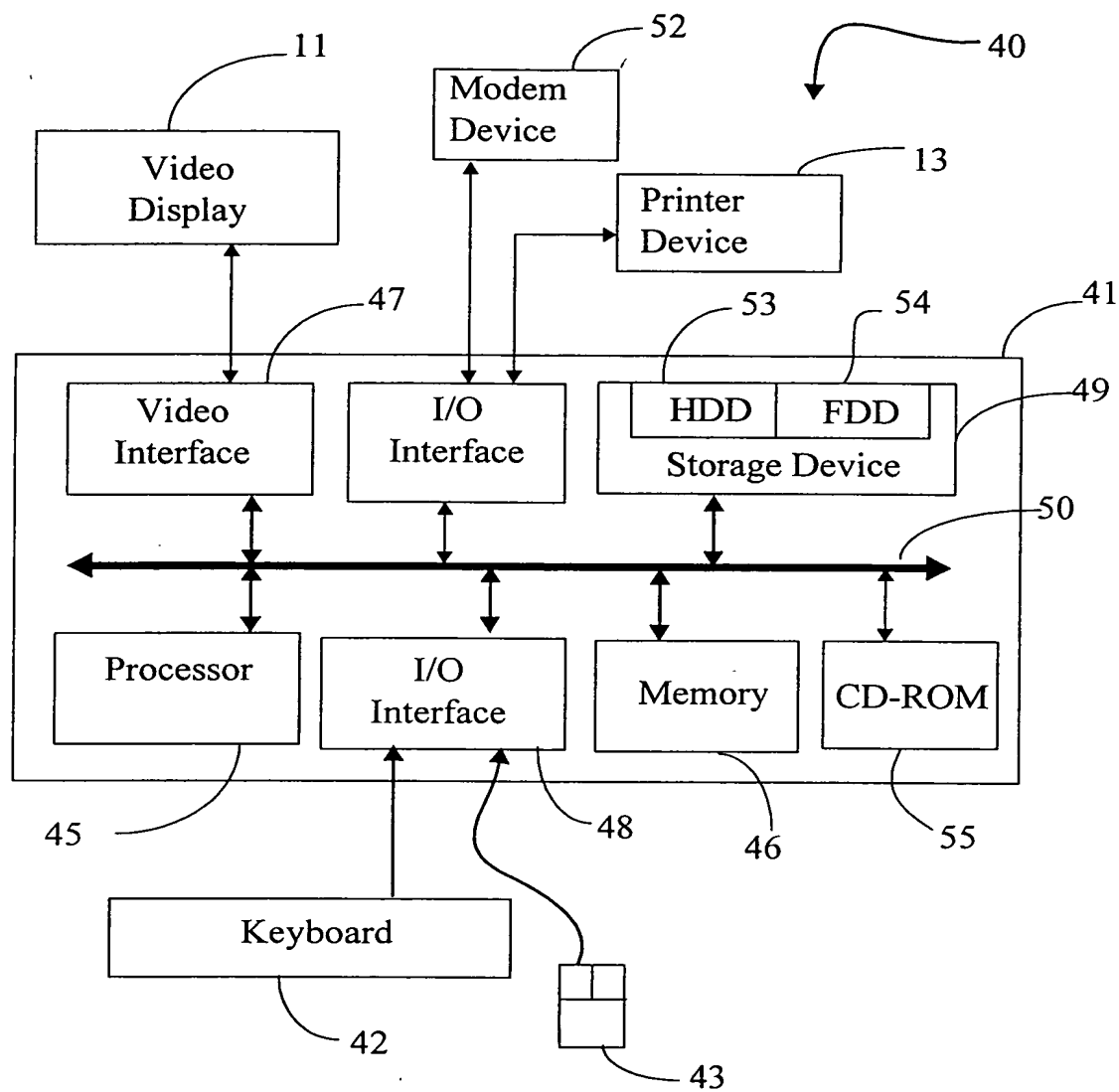


FIG. 9

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APPENDIX 1

-A1-1

METHOD FOR NON-LINEAR DOCUMENT CONVERSION AND PRINTING

Field of the Invention

The present invention relates to formation of a document from one or more sources of information and, in particular, to the reproduction, preferably by printing, of the document onto physical, human readable media in a manner so as to retain in the reproduction certain links or similar structures present in the sources.

Background to the Invention

Techniques exist for the generating, formatting, displaying, saving or printing of structured documents, hierarchical documents, documents written in a markup language such as SGML, HTML or XML, and also for other forms of non-linear documents. Such techniques may provide formatted human-readable clear-text output or another alternative document format or presentation from that of the original document source-data. Typically however, any non-linear or structure information, or hyperlinking facility within the original document source data will be either lost, ignored or rendered solely as textual information which is only passively informative to any reader.

One typical example of a source of tagged or hyperlinked non-linear documents is the so-called world-wide-web (WWW). A user may browse many disparate, but hyperlinked information sources in a non-linear manner on the web with the intent to access, create and print a personalized document containing or including one or more parts of one or more source documents encountered. Typically, the selection by the user of source documents or their partitioning, ultimately for assembly and printing as a single document, is strongly suggested by those tags or hyperlinks contained within the source document or documents. Typically, these tags or hyperlinks interconnect various parts of the source document, or parts of separate source documents with the interconnections being of various types including contextual, referential, informative, descriptive, elaborative, consequential or inconsequential and even linearly progressive.

Currently available arrangements permit a user to gather the document parts or documents' parts of interest and to assemble these into a whole, customized document which will be typically partitioned, cross-referenced or interconnected by the tags or hyperlinks which were distributed within the source documents. These original tags or hyperlinks, as selected by the user, will be the primary means of access and reference internally between sections of the newly customized document and typically, would have been the primary means of selecting or specifying the part or parts of the source documents for assembly of the final customized document. The implication is, therefore, that the user will wish to continue to refer to the tags or hyperlinks as an active and efficient, and perhaps as the sole, means of accessing or referencing the customized document, regardless of its final form, format or medium.

If the user wishes to print a typical customized document containing tags or hyperlinks assembled in the manner described above, then current arrangements permit textual printing of the hyperlinks within the document body, or as an appendix, footnote or similar. Such arrangements therefore cause the loss of the accessibility, active interconnection or referential properties of the hyperlinks through the process of printing the customized document. The user is thus forced to use some other method of accessing, indexing or referencing the contents of the customized document. Typically, the user is forced into a linear access method for the printed document, despite the original selection of the contents being made via a non-linear interconnection or hyperlinked method.

Summary of the Invention

The present invention addresses the above deficiencies through preserving the interconnection and access properties of the original tags or hyperlinks once the customized document has been printed or otherwise reproduced.

In accordance with one aspect of the present invention there is disclosed a method of creating a representation of information from at least one electronically accessible source of said information, said information including at least one referential

link between first matter in said information and second matter in said information, said method comprising the steps of:

electronically extracting said information from said at least one source;

identifying said referential link to establish a referential path between the first
5 matter and the second matter;

arranging the information as a document in a format suitable for hard copy reproduction in which each of said first matter and said second matter are individually identifiable; and

using said referential path to incorporate into said document and format a user
10 interpretable functional link between the first matter and the second matter.

In accordance with another aspect of the present invention there is disclosed a displayable document comprising information for hard copy reproduction, said information including a identifiable first link between first matter within said document and second matter within said document, characterised by a functional second link
15 referring from the first matter to the second matter, said functional second link being formed using a association between the first matter and the second matter reproduced in a user interpretable manner in said document.

In accordance with another aspect of the present invention there is disclosed a document creation system including:

20 means for accessing electronic information intended for reproduction, the information including at least one hyperlink;

means for formatting the accessed information as a contiguous localized document in a reproducible format;

means for incorporating into said localized document at least one functional
25 links related to said at least one hyperlink, said at least one functional links being reproducible in said localized document for replicating a function associated with said at least one hyperlink; and

means for displaying the localized document.

In accordance with another aspect of the present invention there is disclosed a non-linear access method for a hard copy document, said document comprising linearly arranged information and at least one link physically incorporated in said document and coupling first matter in said information with second matter, said method comprising
5 the steps of:

observing a reproduction of said first matter in said information distinguishable from other of said information; and

tracing a physical indicia in said document distinguishable from said information from said first matter to identify said second matter.

10 In accordance with another aspect of the present invention there is disclosed a computer program product comprising a computer readable medium incorporating a series of instructions interpretable by a computer for creating a document, said computer program product including:

a first module for accessing electronic information intended for reproduction,
15 the information including at least one hyperlink;

a second module for formatting the accessed information as a contiguous localized document in a reproducible format;

a third module for incorporating into said localized document at least one functional link related to said at least one hyperlink, said at least one functional link
20 being reproducible in said localized document for replicating a function associated with said at least one hyperlink; and

a fourth module for displaying the localized document.

In accordance with another aspect of the present invention there is disclosed a computer system comprising:

25 input apparatus for interfacing user commands to said system;

a processor device couplable to a computer network from which a plurality of electronic documents are accessible, said documents including one or more hyperlinks, said processor device being configured to operate a computer program in response to said user commands to access selected ones of said documents intended for

reproduction, and to format the accessed documents as a contiguous localized document in a hard copy reproducible format, said formatting including incorporating into said localized document functional links related to said hyperlinks, said functional links being reproducible in a material form in said localized document for replicating
5 functions associated with said hyperlinks; and

a printing device for reproducing said localized document by printing onto a recording medium, said printing device being associated with a further device for forming with said recording medium indicia corresponding to said functional links whereby said indicia are manually accessible using a hard copy reproduction of said
10 localised document to traverse said reproduction in a manner complementing said electronic documents.

Brief Description of the Drawings

A number of preferred embodiments of the present invention will now be described with reference to the drawings in which:

15 Fig. 1 illustrates the conversion of a first (source) document into a second printable document according to the preferred embodiment;

Fig. 2 is a flow chart representing the method implemented by the preferred embodiment;

Fig. 3 is a flow chart detailing step 104 of Fig. 2;

20 Fig. 4 indicates syntax used for hyperlink implementation;

Fig. 5 is an example of a hyperlink conversion according to the preferred embodiment;

Fig. 6 is an example of a hyperlink syntax;

25 Figs. 7A-7C show examples of hyperlink associations according to embodiments of the invention;

Figs. 8A-8C show examples of hyperlink formats according to embodiments of the invention;

Fig. 9 illustrates a document formed using an embodiment;

Fig. 10 is a schematic block diagram representation of a computer system in which the embodiments may be implemented;

Figs. 11A to 11C illustrate the formation of a displayable document according to a simple embodiment; and

5 Fig. 12 is a flow diagram of step 109 of Fig. 2.

Detailed Description

Fig. 11A schematically illustrates three source documents 901, 902 and 903 which may typically be accessed via the World-Wide-Web either directly or indirectly. For example as seen, the first source 901 includes a first text portion 904 which is
10 followed by a hyperlink 905 which, in this example, represents a heading to a second portion of text 906. As seen, the text 906 includes an embedded hyperlink 915. The source document -901 ends with a third portion of text 907.

Hyperlink 905 links the source document 901 with the source document 902 which is seen to commence with a text portion 908 followed by a link destination 909
15 corresponding to the location called by the hyperlink 905. For example, the destination link 909 can be a header to a data portion 910 which may include an image related to the text 906 recited beneath the calling hyperlink 905. In this manner, as will be understood by those familiar with the World-Wide-Web, selecting the hyperlink 905 will automatically cause a traversal of the Web to the link destination 909. As seen in
20 Fig. 11A, the data portion 910 includes an embedded hyperlink 911 which, together with the hyperlink 915, provide a source of access to the third document 903. As seen, the hyperlink 915 accesses a link destination 912 which acts as a header for a data portion 913 which includes a destination link 914 corresponding to the hyperlink 911.

Whilst electronically traversing the World-Wide-Web, hyperlinks permit the
25 user to be immediately transported from one part of the Web to another where appropriate to access the referenced information. However, when hypertext linked documents are extracted from the Web and stored as linear documents within a local computer, such as documents intended for printing or as other forms that do not

support hyperlinks (eg. text only data), or when printed in hard copy form, the electronic traversal function afforded by the hyperlinks is lost.

According to the specific embodiment, where it is desired to create a local document based upon the sources 901, 902 and 903, a linear document 900 is created which is shown in Fig. 11B and formatted into a form ready for display using a printer hard copy output device. As seen in Fig. 11B, in order to obtain appropriate pagination, in this example, the three source documents 901-903 are spread over four display pages. Further, and where appropriate, the various blocks of text and the like are reformatted so as to best occupy the space available on each of the display pages. At this stage, because each of the hyperlinked referenced documents 901-903 are all formed within a contiguous single document 900, the benefits of the non-linear hyperlinking obtained from the World-Wide-Web are lost.

According to this particular example, and as shown in Fig. 11C, the document 900 is modified whereby each of the hyperlinks 905, 915 and 919 and their associated linked destinations 909, 912 and 914 are functionally provided by altering the document of Fig. 11B to provide a functional relationship between the various parts of the document 900 in the form in which it is to be displayed by printing. As seen in Fig. 11C, the heading associated with the original hyperlink 905 is supplemented by a functional link comprising a line 916 displayed on the document and interconnecting the heading/link 905 with a cutout portion 917 arranged on the edge of the page. The cutout portion, by virtue of being on page 1 of the document 900 and overlying page 2, overlies and exposes a colour marked portion 918 on page 2 which, via a rendered line 919 provides a functional link to a heading corresponding to the hyperlink destination 909 seen in Fig. 11A. In this manner the functionality of the original hyperlink found on the Web is maintained in the document 900 through providing a user thereof with a ready means of traversing the document 900 between appropriately linked portions thereof.

Where the display document of Fig. 11C is printed in hard copy form, the cutout portion 917 can be physically cut from the paper of the document thereby

providing a direct page access functional reference between the link 905 on page 1 and its destination 909 on page 2.

As further seen in Fig. 11C, the link 915 is embedded within the second portion of text 906 and such positioning is not conducive to the use of a line, corresponding for example to the line 916, to link with an appropriate cutout portion. In this case, the graphic identifier 920 is associated with the hyperlink 915 and refers to an associated cutout portion 921 which is provided with the same graphic symbol 925. As seen, the cutout portion 921 overlies an unreferenced cutout portion 922 on page 2 and a corresponding shaded portion 923 on page 3 which connects, via an indicator line 924 to the destination hyperlink 912. In this manner, the arrangement of functional links within the display document of Fig. 11C can be provided in such a manner so as not to impact upon the readability of the document yet afford the ability to traverse the display document 900 in a manner corresponding to that which would be available using the electronic hyperlinks sourced from the World-Wide-Web.

As indicated above, where the display document 900 of Fig. 11C is printed on hard copy form, the cutouts are physically cut out from the edge of the medium (paper). Further, tabs that protrude from the edge of the medium may be used as an alternative or in addition to the cutouts.

From the simple example of Figs. 11A, 11B and 11C, it will be apparent that the present invention provides for maintaining non-linear hyperlinks extracted from the World-Wide-Web in linear, local display documents intended for hard copy reproduction. The hyperlinks remain in a functional manner and maintain the linking between various pages or components of the document. In a preferred implementation, the display document 900 can be configured for reproduction upon a video display as a video simulation of the hard copy document and in such an application, the cutouts or tabs may be formed as user selectable icons which reproduce, in the local computing environment, the same effect as that available on the World-Wide-Web and that available using the hard copy document.

Fig. 1 shows an example first document 10 which includes one or more pages or sections 12 and 18, both of which may be described by a markup language or languages such as HTML or XML or the like. The first document 10 will typically be accessed by browsing on the world-wide-web or some other similar information source.

5 The first document 10 generally contains one or more "typical" pages, for example the page 12, referred to herein as First Document Page X, to indicate that there is no specific or ordinal reference or location for First Document Page X 12, within the first document 10. Particularly there is no specific or relative position nor ordinality of the page 12 with reference to any other page or pages, for example represented herein by
10 First Document Page Y 18, also contained within the aforesaid first document 10. Similarly the First Document Page Y 18 also has no specific or ordinal reference or location within the first document 10.

The First Document Page X 12, includes a hyperlink 14 or similar feature of equivalent functionality and accessibility, represented visibly or by other means suitable
15 for detection by human senses. The hyperlink 14 provides an interconnection, reference and/or access 16, to the First Document Page Y 18, or to some part 20 of the First Document Page Y 18. The part 20 can, for example be a section, graphic or a textual element, to name but a few. The hyperlink 14 may reference the First Document Page Y 18, via any positive or negative ordinal, relative or absolute path that
20 is necessary or optional to implement the hyperlink interconnection 16 within the first document 10. Such an arrangement provides a location-to-location linking between sources of information. Alternatively, a content-to-content linking of the sources of information may be implemented.

Prior art arrangements, such as those discussed above, when printing the first
25 document 10, whilst being able to visually represent the hyperlink 14, for example by reproducing the text thereof as a footer or contents listing, are unable to reproduce the functional and referential properties of the link 16 between the two pages 12 and 18.

The preferred embodiment provides a method associated with the processing and printing or rendering of the first document 10, to produce a physical copy or

representation 40, including the First Document Page X 12 and First Document Page Y 18, and also including visible representation of hyperlinks 14, within the First Document Page X. Further, the actual hyperlink reference 16, as distinct from the visible representation 14 of the same hyperlink, is retained within the printed copy 40, as a functional and accessible feature 46, of the printed copy 40 of the first document 10. As seen in Fig. 1, the printed document 40 contains printed copies or representations of the component parts of first document 10, with the Second Document Page X 42 representing a printed copy of the First Document Page X 12, and the Second Document Page Y 48, representing a printed copy of the First Document Page Y 18. Fig. 1 also shows an example of a printed representation 44 of the visible representation 14 of the hyperlink 16. In this embodiment, the visual representation 44 of the hyperlink is associated with a functional reference 46 to the actually referenced part 50 which in this case appears on a separate page 48 of the second document 40. As illustrated in Fig. 1, the functional reference 46 includes a printed line 52 extending from the visual representation to a page finger tab (cut-out) 54 which directly references, through manual operation of the second document 40, the page Y 48 on which the actually referenced part 50 is found.

Clarification may be required of the distinction between the visible representation 44 of a hyperlink and the functional/virtual/physical activation 46, of the same hyperlink. A hyperlink may be displayed, rendered or printed purely as a textual or graphical element, in which case only the visible portion 44, of the hyperlink exists in the printed document 40. Such a hyperlink will be non-functional and will normally only have the same attributes as other text in the same document or page as found in the prior art. Alternatively, in the preferred embodiment it is normally intended for a hyperlink in a world-wide-web HTML page 10, or equivalent, to also have a functional property 16, associated with its visible property 14. In the environment of an HTML web page 10, or equivalent, the functional property 16 is available within a web browser window and typically permits a user to traverse within or between hyperlinked pages or documents. Prior art arrangements do not provide for the retention of this

hyperlink functional property 16, once an HTML page is printed or rendered to a physical medium. In Fig. 1, the hyperlink property 46 in the printed document 40, is typically inactivated or lost when original hyperlink 16 in Web page document 10 is processed or printed by prior art methods. In such a case, only the visible property 44
5 of the hyperlink is preserved or copied from the original visible property 14 (if at all).

Whilst the above refers primarily to documents sourced from the WWW, other documents may be used as appropriate sources of information. These include, but are not limited to, user or self generated documents that contain referential links, and also existing documents where referential links are added by the user. A further class of
10 documents include those in the process of creation, as will become apparent in the following description

The described embodiments of the present invention may be practiced using a conventional general-purpose (host) computer system, such as the computer system 60 shown in Fig. 10, wherein an application program developed to produce the results
15 shown in Fig. 1 discussed above and to be described with reference to the other drawings is implemented as software executed on the computer system 60. The computer system 60 includes a computer module 61, input devices such as a keyboard 62 and mouse 63, output devices including a printer 64 and a display device 65. A Modulator-Demodulator (Modem) transceiver device 66 is used by the
20 computer module 61 for communicating to and from a computer network, -and is for example connectable via a telephone line or other functional medium. The modem 66 can be used to obtain access to the Internet, and other network systems, including the World Wide Web.

The computer module 61 typically includes at least one processor unit 67, a
25 memory unit 68, for example formed from semiconductor random access memory (RAM) and read only memory (ROM), input/output (I/O) interfaces including a video interface 69, and an I/O interface 70 for the keyboard 62 and mouse 63. A storage device 71 is provided and typically includes a hard disk drive 72 and a floppy disk drive 73. A CD-ROM drive 74 is typically provided as a non-volatile source of data.

The components 67 to 74 of the computer module 61, typically communicate via an interconnected bus 75 and in a manner which results in a conventional mode of operation of the computer system 60 known to those in the relevant art. Examples of computers on which the embodiments can be practiced include IBM-PC/ATs and compatibles, Sun Sparcstations or alike computer systems. Typically, the application program of the preferred embodiment is resident on the hard disk drive 72 and read and controlled using the processor 67. Intermediate storage of the program and display data and any data fetched from the network may be accomplished using the semiconductor memory 68, possibly in concert with the hard disk drive 72. In some instances, the application program, which incorporates the present invention, may be supplied to the user as a physical product, for example encoded on a CD-ROM or floppy disk, or alternatively could be supplied to the user as a virtual product, for example through the user reading the program from the network via the modem device 66. The application program, whether sourced from a disk device such as CD-ROM or floppy disk, from the computer network, or some other arrangement (eg. tape drive, PCMCIA card, DVD etc) is typically retained in the hard disk drive 72 and executed in or with the aid of the RAM 68. Alternatively, or additionally, the application program may be incorporated into a printer and/or cutter device, although such implementation may impact upon the full extent of user functionality to be described.

In the preferred embodiments, the printer 64 is of a type configured not only to print an image upon a medium, but also to create finger cut-outs of the type seen in Fig. 1. An alternative printer is one that is able to apply a tab to a printed page or other physical feature that may operate as a functional link for predetermined referential links. Alternatively, the referential markers (cutouts, tabs, etc) may be applied by separate printing and cutting devices controlled by the computer. Further, the referential links may be marked on a printed page by a printer and referential markers (cutouts, tabs, etc.) applied manually to pages so marked.

A physical document produced according to the present invention may be formed in a number of ways, a first of which involves reproducing the printed matter

and physical hyperlinks essentially simultaneously using a unitary printer/cutting-type device. An example of such a device is the *Fargo Impresa Die Sublimation Resin-Wax Thermal Label Printer* manufactured by Fargo Electronics Inc., of the USA.

An other way of producing such a document is to first print the document,
5 which can be achieved using any one of a plethora of printing systems known to those in the art. The printed pages can then be cut using a controllable cutting device to produce the physical hyperlinks such as the tabs and cut-outs. An example of such a cutting device is the *FC3100-60 Desktop Grit-Rolling Cutting Plotter* manufactured by Graphtec Technologies of Florida, USA. This device utilizes computer controlled
10 knives to cut the printed medium (eg. paper) and operates in a manner akin to plotter-printing devices, known to those skilled in the printing arts. Other cutting mechanisms may also be used. For example, punching finds ready application in situations where many pages require corresponding cut-outs to be formed, for example in the creation of finger tabs.

15 A still further way of producing such a physical document is to first cut the medium (eg. paper sheets) in the required manner to produce the physical hyperlinks, and then print onto the medium the required text and other information including printed hyperlinks. Such an approach is however unlikely to be preferred as, in general, printing systems operate most efficiently when handling uniformly shaped
20 and/or sized material.

A future way of producing the physical document is to generate the document electronically, and retain the same on a recording medium, the medium then being supplied to a printer/cutter system for physical reproduction of the document retained on the medium.

25 In detail, the first document 10 seen in Fig. 1 typically comprises at least one HTML Web page or similar or equivalent. For the purposes of the explanation, the first document 10 will be described as containing two Web pages 12 and 18, linked by a typical hyperlink 16. These two pages 12 and 18 may be interspersed amongst other pages, need have no linear connection or commonality (such as page numbering), and

may be in any order (if indeed the term 'order' is applicable to the storage or referencing method for first document 10). Indeed, the two web pages 12 and 18, may be from separate original web documents, or may in fact be separated by any physical or virtual or Internet distance. Therefore, the first document 10 may be a virtual document, inasmuch as it may contain or include web pages which are from separate or disparate sources and the definition of the contents of the first document 10, may be purely a user definition, being possibly temporary, transitory, or ephemeral, for instance, merely existing in the mind of the user or in some construct relating to the operation of a user's web browser or similar application.

Document 10, whether it be originally constructed or intended to include or reference or hyperlink to pages 12 and 18, would typically include hyperlinks interconnecting most or all pages, as this is the typical method of referral between web pages. This typical interconnecting or hyperlinking between pages, whatever their origin, to form a virtual document (or documents) is a common method of obtaining information from the World-Wide-Web and forms the typical starting point for the described embodiment. However, any hyperlinking method within the first document 10 may be used.

The preferred embodiment allows the user to control, either manually, or by some automatic method, to select and store web pages from the Internet or World-Wide-Web to form a first document 10, which is further processed and finally printed and cut to produce a second document 40, which is in physical form. The second document 40 will typically contain the same content as contained within first document 10 with similar, parallel, analogous or identical hyperlinking connections between content or pages of the document 40, as were originally present in document 10. Indeed, it is desirable to provide as much similarity, parallelism, analogy or identity between the hyperlinking methods of both forms of the document 10 and 40, however, the method of the invention may permit the user to modify the document 40 to contain changes to the hyperlinking connections from those included in first document 10. In addition, it is desirable to accommodate and comply with the

constraints of the output or printing medium in production of the document 40, in which case identical implementations or arrangements of content and hyperlinking may not be possible between documents 10 and 40 and the invention will attempt to find and implement or offer the user a suitable alternative or compromise arrangement of content or implementation of hyperlinking.

The first document 10 includes a page 12, which contains a hyperlink 16, pointing to some content 20, on page 18. The direction, numerical page increment or decrement, or address details of the hyperlink 16, are unimportant. The preferred embodiment records the document and page positions of the hyperlink start point 14, and end point 20, and any content-relevant details including which element or elements the hyperlink attaches to, how it is positioned within the page or pages relative to adjacent elements, etc. The hyperlink 16 typically includes several attributes, including a starting point 14, normally defined as being connected to a content element such as text or an image or graphic. The hyperlink starting point 14, also represents the visible attribute of the hyperlink, which need not be present, but is typically present to indicate (eg. visually) the availability of the hyperlink to a user. A typical method of operating a hyperlink is to select, click or otherwise activate the visible attribute, 14, which operation indicates to a user's browser software to analyse the attributes of the hyperlink to find the end point address or reference 20 within those attributes and to traverse the contents of the first document 10 directly to the indicated end point address 20, typically without considering or displaying any other content which may exist between the start point 14 and the end point 20. One example of a hyperlink syntax is indicated in Fig. 4, in which the hyperlink attributes are defined and enclosed within the markers "<A" and "". For the purposes of this description, the hyperlink 16, includes its attribute information, such as start point 14, and end point 20, but excludes its visible attribute or appearance which is indicated by the text seen at 14 in Fig. 1. The hyperlink 16 is also used to refer to the action of traversing the document 10 from start point 14 to end point 20.

Referring to Figs. 1 and 2, after the first document 10 is created, defined or stored in memory as indicated as step 101 in Fig. 2, the document contents are copied and stored within local memory or storage, as indicated by step 102. Next, if required, in step 103 hyperlink attributes which involve absolute pathnames, or those attributes
5 containing references to the original external first document 10, are converted to internal and/or relative references or pathnames so that the local or internal copy of the first document 10 contains self-consistent hyperlinks which refer, as much as possible, only to the internal or local first document 10 and not to the original, external first document 10.

10 Next, at step 104, the internal copy of the first document 10, is processed, typically including reformatting of pages and document elements and content, to satisfy various constraints, options or parameters imposed upon the process. The major purpose of step 104 is to reformat the document to meet the constraints of the final medium, for instance, printed, cut and bound paper sheets in book or booklet form. It
15 is typically the case that the content and page layout of an HTML web page first document 10, is unsuitable for or incompatible with direct printing to paper. Therefore, reformatting may be required. Step 104 typically comprises several operations which may involve iteration or interaction and these are indicated in Fig. 3.

Step 104 includes the step 151 of recording and storing the parameters of first
20 document 10, including document and page layout and formatting parameters and properties, such as page orientation, page size, quantity of pages, font sizes and properties, together with information regarding the element positions and dimensions and other properties, relative placement of elements and spatial (eg. z-axis) or overlay, relationships of elements. Next, user options and controls, including any selected
25 control and/or reformatting template, are recorded and stored in step 152. Step 153 follows in which hyperlink attributes, start and end points, spatial and visible relationships or attachments with other document elements and any other relevant properties or parameters are recorded and stored for first document 10. This operation may be performed by searching the first document 10, for syntactical elements or

semantic relationships as defined in or allowed by the applicable HTML standard or standards, where the syntactical elements or semantic relationships indicate or declare hyperlinks or related attributes within the first document 10. Steps 151, 152 and 153 may be operated in any particular order or combination that is practical.

5 Step 154 follows step 153 and includes the reformatting of the first document 10, into a format or layout more suitable to meeting the various constraints for printing and also in obedience to the controls, parameters, constraints, properties or templates recorded or selected and stored in steps 151, 152 and 153. Various operations may be undertaken to effect the reformatting of the document, including
10 repositioning of elements or pages, page-splitting or merging, reorienting of elements or pages, alteration of spatial relationships of document parts, pages or elements, modification of font properties and visible attributes of elements, such as highlighting, etc to better suit the conventions or physical properties of the intended medium, or to meet the constraints or requirements selected or defined in steps 151, 152 and 153.
15 Typically, it will be necessary to reformat the first document 10, into a linear sequence of pages 40, since such linearity is typically enforced by the physical nature of the printed medium. Such a structural modification of a typically non-linear document 10, to a linear format in document 40, will typically have a significant impact on the arrangement and layout of pages and of page content. It will typically be the case that
20 special processing of the document content and format may be necessary to retain or to partially retain an analogy, parallelism or identity between the structure and layout of first document 10, and the structure and layout of second document 40. In addition to such reformatting operations, it is typical that hyperlinks in the original document 10 may have their visible attributes modified to meet the constraints of the new medium
25 used for physical document 40, or to satisfy the requirements of the selections or controls input in steps 151, 152 and 153. In addition to any minimum required or recommended modifications to hyperlinks' attributes in original document 10, suitable for inclusion or reproduction in physical document 40, there may be further attribute modifications which are automatically performed or recommended to the user, possibly

including standard alterations to hyperlinks' visible attributes. For instance, highlighting in colour, or underlining or other hyperlink attribute treatments, which may be optionally replaced or further enhanced by any relevant input controls, constraints, options or selections recorded in steps 151, 152, 153. It is possible that
5 such treatment of hyperlink visible attributes may be controlled or influenced by a template or a template property, properties, parameter or parameters, any or all of which may be selected by the user.

Further to the treatment of hyperlinks in step 154, step 155 which follows may include the treatment of hyperlinks relating to the specific relationship of the hyperlink
10 to surrounding or adjacent content or the further treatment may relate to any presentation control, constraints, parameters or properties be they specific or default, associated with the content, the web page, the document, or referred to by the latter. An example of such presentation control is the Cascading Style Sheet method. This method allows an HTML web page to refer to, or associate, a Style Sheet with the
15 HTML content, including association with hyperlinks, to control or modify or enhance the presentation of the document 10, or the document 40 and its contents, optionally with treatment specifically for the intended presentation medium. In addition to this possible treatment of document content and specifically to the treatment of hyperlink attributes, the treatment of hyperlink attributes, either replacing, modifying or
20 enhancing any foregoing treatment, so as to provide improved placement, or highlighting, emphasis or legibility of hyperlinks within the format and constraints of the destination medium, typically a printed, cut and bound collection of paper sheets 40 can be implemented.

Further treatment of hyperlinks for a printed and cut HTML document 40, or
25 for a printed, cut and bound HTML document 40 can be provided through additional processing, formatting, highlighting, and other treatment of hyperlinks than are available. These additional processing and treatments of hyperlinks in step 155 can be varied under user or automatic control, and may depend on aforementioned constraints such as the dimensions and other properties of the destination printed document 40 and

its format, but are generally intended to include rearrangement of hyperlink-associated content elements, such as text, images or graphics to better position hyperlinks closer to page edges for later cutting of tabs or access holes, or positioning for better highlighting by addition of a graphic element or colour or other highlight effect or possibly combinations of the aforementioned treatments.

Figs. 7A to 7C illustrates some examples of possible hyperlink treatments for the purpose of associating hyperlinked content from first document 10, with tabs or cutouts or other physical hyperlink element or elements within printed document 40. The examples in Figs. 7A to 7C may be derived from the example HTML syntax in Fig. 4, which illustrates a textual element containing a single word, "link" which has a hyperlink associated with it. Generally, unless the user specifies otherwise, a hyperlinked element, such as the example given, "link", is associated with a physical hyperlink in document 40, where the physical hyperlink typically takes the form of a cutout or tab or similar. This combination or association of hyperlinked element and physical hyperlink is typically and purposefully made to provide an operative, actual and active hyperlinking facility in the printed and cut document, 40 which mimics, parallels, or recreates the original hyperlinking facility within the first document 10.

In Fig. 7A, a page 203 contains a sentence with a hyperlink originally associated with the word "link" in the first document 10. In the printed and cut document 40, the preferred embodiment makes a visual and direct association between the hyperlinked word "link" 204, and a physical hyperlink tab or cutout, 205, which is created and allocated for the purpose of effecting the hyperlink action. In Fig. 7A, the hyperlink and text are loosely associated with the physical hyperlink cutout 205, by allocating relatively close positioning for the two elements and with the addition of a printed symbol 220 next to or near to physical hyperlink 205. The symbol 220 is placed adjacent to physical cutout 205 to mark it, to give it meaning and to draw attention to it and, usually, to associate physical hyperlink cutout, 205, with the original hyperlinked text, 204. Further in Fig. 7A, the association between the hyperlinked word 204 and the cutout 205, depends on the selection of a suitably explanatory

graphic, image or text element at 220. Such a selection and/or treatment may be controlled by an automated processing template or script, or by the user.

In a second example seen in Fig. 7B, an arrow 221 is drawn between the hyperlinked word "link" 204, and the physical hyperlink cutout 205. The arrow 221 serves to provide a direct visual connection between the hyperlinked word 204 and the physical hyperlink 205.

A third example of treatment or highlighting of a hyperlink is indicated in Fig. 7C. There, the textual element is repositioned and reformatted to directly place the hyperlinked word "link" 204, immediately adjacent the physical hyperlink cutout 205. This adjacent positioning serves to provide a direct visual connection or association between the hyperlinked word 204, and the physical hyperlink 205.

Many other methods of treatment or highlighting of hyperlinks or association of hyperlinked elements with physical hyperlinks are possible. Treatments or association methods may vary with the details or attributes of a hyperlink within the original document 10. For instance, treatment may vary depending on whether the hyperlink was part of a heading, or body text. In addition, the method implemented for treatment of a hyperlink may vary according to user control or template influence or similar. The options for treatment of a hyperlink, including the method of associating a hyperlinked element with a physical hyperlink, may be controlled or selected from many possible information sources, including user input, parameters or properties within the original first document 10, associations or references within first document 10 to style sheets, automatic or manual selection of a processing or treatment template or procedure or also by adoption of a default treatment or procedure in the absence of some or all of the aforementioned information sources. The same options may be available per element or element type in addition to on a per page or per document or per page type or per document type basis.

Figs. 5A and 5B illustrate how a hyperlink 202 in a source document 201 may be reproduced using a number of finger cut-outs 205,206,207 on an output document 203 having the same visual hyperlink 204.

Step 155 of Fig. 3 may include known treatment or processing steps and typically relating to printing of documents. In addition, the preferred embodiment provides the additional or alternative treatment or processing option for document formatting and/or hyperlink attribute enhancement within step 155, particularly for
5 printing, cutting and/or binding of documents, including for printing, cutting or binding of single or double-sided documents or any combination of these.

Step 155 may be followed by one or more iterations through steps 151, 152, 153, 154, 155, depending on the user control and other constraints. Typically it may be necessary to iterate through the reformatting and placement step 154, because
10 step 155 may influence the document layout in various ways, possibly causing layout errors or requiring elements to be moved or modified near treatments applied to hyperlinks and physical hyperlinks. Generally, if any modification of the document properties, layout, etc has been effected, then steps 152, 153 may need to be repeated.

Step 156 involves the optional presentation on a display of a representation of
15 the reformatted, processed and treated document 40, prior to the final operations of printing, cutting and binding to actually produce document 40. The step 156 is typically known as WYSIWYG (ie: "What you see is what you get"). The user may take this opportunity to check the document presentation and to effect revisions of the user controls and options if desired. Such changes may require reiteration of earlier
20 steps 151, 152, 153, 154, 155 and 156 to check or to modify the document structure and attributes so as to avoid violation of any preset, assumed, derived or selected constraints relevant to these steps.

Step 157 involves the final calculation of the start and end position attributes of all hyperlinks within document 40. Step 157 is similar to step 153 and the procedural
25 loop indicated may be rearranged to combine these steps with an equivalent result. Step 157 replaces the hyperlink attributes recorded from first document 10, with the attributes from the reformatted document 40. These attributes, now relevant to the domain of a printed and cut and/or bound document, are used for the purposes of grouping, positioning and associating hyperlink-associated content elements and

physical hyperlinks within the domain of an entire document, typically containing multiple pages.

Following step 157, step 105 as seen in Fig. 2 offers the user the option to select or deselect hyperlinks or physical hyperlinks for display, printing or cutting within the printed and cut document 40. If the user chooses to modify the status, inclusion, printing or cutting of a hyperlink or physical hyperlink in document 40, then such changes may require alteration or compensation in the document format, layout, presentation properties, etc and an iteration may be required for steps 104 and/or 105 to reprocess the document 40. This decision to reprocess may be made separately or jointly by the user or the particular implementation of the invention. The user's option to select or deselect hyperlinks or physical hyperlinks for display, printing or cutting in step 105 is provided to permit the user to generate an optimal or customized format for the document 40 and hyperlinking strategy. For example, the original document 10 may have included a large quantity of hyperlinks which cannot practically be reproduced as physical hyperlinks because of physical spatial constraints for example, or for presentation and ergonomic reasons where a plethora of physical hyperlinks may have a negative effect on the presentation or ease of use of the document 40. Other reasons may exist for selecting or deselecting hyperlinks and physical hyperlinks for inclusion in a document, including for achieving some intended style or appearance, or for information presentation reasons, for instance for reducing clutter and enhancing high priority information, and so on. Such selection or deselection decisions may also be performed by automatic means or a combination of automatic and manual means, including under the control of templates, media parameters, properties or constraints, etc and as described for steps 151, 152, 153.

Step 106 involves the automatic, manual or interactive selection of the physical position of one or more hyperlinks, including optional grouping and positioning of a plurality of hyperlinks. The grouping or positioning of hyperlinks includes grouping or positioning or association between one hyperlink and another hyperlink, or between one hyperlink and a number of hyperlinks, or association between hyperlink and physical

page properties, or an association between a hyperlink and physical document properties and includes optional groupings or position in one or any combination of all three physical, spatial dimensions, where the surface of a single page may be considered as containing two spatial dimensions. Also the absolute page number, or relative page number, physical document depth, leaf side, page side (in a two-sided document) or other equivalent description may describe, and be equivalent to, the third spatial dimension. Information suggesting grouping and/or positioning of hyperlinks, either singly or in a plurality, may be automatically derived from information available during any of its previous steps. For instance, the original hyperlink information may have been grouped on one page or in one headed section of the original document, or hyperlinks having the same hierarchical level, for instance, having the same header level declaration in HTML syntax, may be grouped. For example, Fig. 6 shows a typical HTML hyperlink syntax in the first line of text, where a hyperlink is explicitly associated with a textual element which is explicitly raised to a header level of 1. There may be many kinds of hyperlink grouping and positioning information and there may be many methods for automatically interpreting hyperlink grouping and positioning information. The selection of which method or methods of selecting or interpreting hyperlink grouping or positioning information may be by means of default methods implemented at the inventor's discretion, or by means of analysis or recognition of the format of the input document 10 and by selection of an appropriate analysis technique which results in an optimal or acceptable hyperlink grouping and positioning. Alternatively, a user's selection of a template which may specify many parameters or which may control many processes of the preferred embodiment, including the hyperlink grouping or positioning information analysis and interpretation and resultant placement in order to achieve a consistent or familiar style, method, presentation or result at the output can be applied.

Further options within step 106 include the option for the user to override or modify aspects of the grouping and positioning data or decisions. The user may optionally compound or iteratively modify the grouping and positioning information,

and typically, a WYSIWYG or partial display of the expected output is provided to assist and guide the user during this procedure. Step 106 may be repeated in a loop or loops with other steps as indicated in Fig. 2, passing control via steps 113 or 114 to previous steps, as the user or as the method of the invention decide are necessary.

5 Other implementations may combine step 106 with one or more of the other steps, for instance, step 105, to provide a combined operation to the user and also to possibly provide more related information at one stage to allow better automatic control and decision making within the invention's process steps. Step 106 may also occur at a different stage in the flowchart of Fig. 2, where it may be used to constrain other
10 processes, such as that in step 105, for instance. An example of this optional implementation may include where step 106 precedes step 105 and step 106 constrains the grouping and positioning of hyperlinks, by automatic or manual means or both, so that decisions made in the following step 105 are constrained by this predetermined grouping or positioning to, for instance, determine, or partially determine implicitly or
15 explicitly the priority of hyperlinks which may be selected and printed or cut to the exclusion of lower priority hyperlinks.

Step 107 involves automatic, manual or interactive selection of the type or types of printing, marking, or identifying, by visual, tactile or other means, or other physical presentation of one or more hyperlinks, including the method or methods of
20 associating hyperlinks with one or more document or page elements, particularly but not exclusively, printed elements, within one or more pages. Step 107 may be additional to similar decisions, analyses or options or operations previously performed in step 155 of Fig. 2. Typically, step 155 would involve automatic or default operations, based on analyses of input data and prior control or formatting template
25 selection or similar, whereas step 107 may typically involve significantly more user interaction or control and may also include additional data from steps 105 and 106 which was typically unavailable in step 155 and which may influence automatic or manual decisions made in step 107. Step 155 was performed earlier to typically provide enough information about proposed or default document elements, structure

and attributes to permit meaningful processing and decision-making in subsequent steps. Step 107 then provides the opportunity to revise or finalise such attribute values or decisions previously made in step 155. Amalgamation or other association of process steps 155 and 107 is possible while retaining an equivalent method of invention.

5 In the example of Fig. 7A, the physical hyperlink 205 is highlighted by a graphic element 220, which is printed nearby. This element may have been copied or extracted from the original document 10, or it may have been introduced by the embodiment or by the user to bring attention to or a style of presentation to hyperlink 205. In addition, the hyperlink 205 is associated with textual element 204 by
10 general positioning of the two in the same area. Another example of positional association is seen in Fig. 7C in which the textual element 204 is positioned directly adjacent to the hyperlink 205. The middle example of Fig. 7B illustrates a more direct association method between hyperlink 205 and textual element 204, by the method of printing a connecting arrow or equivalent feature 221. One typical and easily derived
15 association allowing the printing of arrow 221 may be obtained by detecting from original document 10, the explicit association of a document element with a hyperlink. For example, such an association is expressed in HTML syntax in Fig. 4 in which the textual element, word "link" is explicitly associated with the HTML hyperlink property. Therefore, the preferred embodiment may detect this explicit association and
20 render the physically hyperlinked document, 10, as shown in the in Fig. 7B, with the printed textual element word "link" 204, directly associated with the hyperlink 205, by adding a feature, such as the printed arrow 221.

Information suggesting hyperlink presentation and/or element association, either singly or in a plurality, may be automatically derived from information available
25 to the invention or inferred by it during any of its previous steps. For instance, the original hyperlink information may have been grouped on one page or in one headed section of the original document 10, indicating a possible association between page elements and hyperlinks. Such information is typically available from HTML documents wherein hyperlinks are normally associated with document elements,

typically text or images, and such associations are easily detectable and such associative information may be directly utilized in step 107 to associate or present hyperlinks with document elements.

For instance, Fig. 6 shows an example of a typical HTML hyperlink syntax in the first line of text, wherein a hyperlink is explicitly associated with a textual element. There may be many kinds of hyperlink presentation and/or element association information and there may be many methods for automatically interpreting hyperlink presentation and/or element association information. The selection of which method or methods of selecting or interpreting hyperlink presentation and/or element association information may be by means of default methods implemented at the user's discretion, or by means of analysis or recognition of the format or syntax or hierarchical type or presentation style of the input document 10 and by selection of an appropriate analysis technique which results in an optimal or acceptable hyperlink presentation and/or element association. Alternatively, this can be achieved by means of a user's selection of a template which may specify many parameters or which may control many processes of the embodiment, including the hyperlink presentation and/or element association information analysis and interpretation and resultant placement in order to achieve a consistent or familiar style, method, presentation or result at the output.

Further options within step 107 include the option for the user to override or modify aspects of the hyperlink presentation and/or element association data or decisions. The user may optionally compound or iteratively modify the hyperlink presentation and/or element association information, and a WYSIWYG or partial display of the expected output may be provided to assist and guide the user during this procedure. Step 107 may be repeated in a loop or loops with other steps as indicated in Fig. 2, passing control via 115 or 116 to previous steps. Other implementations may combine step 107 with one or more steps, for instance, steps 105 and/or 106, to provide a combined operation to the user and also to possibly provide more related information at one point to allow better automatic control within the invention's processes. Step 107 may also occur at a different point in the flowchart of Fig. 2,

including at an earlier point, where it may be used to constrain other processes, such as that in step 106, for instance. An example of this optional implementation may include where step 107 precedes step 106 and step 107 constrains the hyperlink presentation and/or element associations, by automatic or manual means or both, so that decisions made in the following step 106 are constrained by this predetermined grouping or positioning to, for instance, determine, or partially determine implicitly or explicitly the grouping or positioning of hyperlinks within one page or within a collection of possibly associated pages.

Step 108 involves automatic, manual or interactive selection of the type or types of hyperlink physical implementation, for instance, the method of cutting of the physical hyperlink tab or finger hole or other physical implementation, including any tactile implementation which achieves the same effect of optional non-linear movement through a document. Fig. 8 indicates three examples of hyperlink implementation on a page 203. In Fig. 8A, a physical hyperlink 230 is implemented by a cut or finger-hole in the edge of the document page. Such a cut may be performed in many document pages, preferably aligned so as to overlap when the pages of the document are aligned to overlap. The hyperlink 230 may be activated by the user placing a finger or thumb within the cut-out and locating the first uncut page surface above or below the cutout, whichever is appropriate, implied or indicated, and next opening that corresponding page or pages, typically by grasping the said surface of the first uncut page above or beneath the hyperlink hole.

Fig. 8B indicates another implementation example for a physical hyperlink 240, in which a tab is presented for, typically, grasping between finger and thumb and opening at the page indicated by the tab. In this implementation, the tab 240 is typically connected with or forms part of the destination page and not part of the current page, as does the hyperlink finger hole 230 of Fig. 8A. Typically, therefore, the tab 240 is provided with some form of association with document or page elements on pages other than the page to which it is connected or a part of. For example, in Fig. 8B, the hyperlink tab 240 will generally be connected with a page below page 203.

Tab 240 is preferably labelled printed, cut, positioned or otherwise associated with an element, for instance the textual element shown, on page 203 and therefore hyperlink 240 will display and will also effect a hyperlink between the textual element on page 203 and the page connected to hyperlink tab 240.

5 Fig. 8C indicates a third example of a physical hyperlink implementation in which several hyperlinks are grouped and associated together. A hyperlink 250 seen in Fig. 8C represents a group of nested finger-hole cutouts of varying but coordinated and progressive size, and of elliptical shape which allow a user to select which hyperlink and therefore which destination page to traverse to by simply moving the thumb or
10 finger slightly to grasp the desired size of ellipsoidal cutout. In conjunction with this implementation example of a physical hyperlink or a plurality of physical hyperlinks, other attributes or features may be included, such as highlighting or colour-coding of the differing sizes of ellipsoidal cut-out, association by colour or other attribute of ellipsoidal cutouts with different elements of a page or pages or other equivalent or
15 equivalently effective methods.

Information suggesting hyperlink physical implementation, either singly or in a plurality, may be automatically derived or inferred from information available to the invention during any of its previous steps. For instance, the original hyperlink information may have been grouped on one page or in one headed section of the
20 original document 10, indicating a possible association between page elements and hyperlinks. Such information is typically available from HTML documents wherein hyperlinks are normally associated with document elements, typically text or images, and such associations are easily detectable and such associative information may be directly utilized in step 108 to determine the appropriate or preferred or optional
25 implementation of hyperlinks. For instance, the selection, grouping, positioning or association of hyperlinks made within steps 105, 106, 107 may be used to select, imply, modify or constrain the method of implementation of one or more hyperlinks or hyperlink groups. There may be many kinds of hyperlink physical implementation information and there may be many methods for automatically interpreting hyperlink

physical implementation information. The selection of which method or methods of selecting or interpreting hyperlink physical implementation information may be by means of default methods implemented within the process at the user's discretion, or by means of analysis or recognition of the format, syntax, hierarchical type or presentation style input document 10 and by selection of an appropriate analysis technique which will result in an optimal or acceptable hyperlink physical implementation association.

Further options within step 108 include the option for the user to override or modify aspects of the hyperlink physical implementation data or decisions. The user may optionally compound or iteratively modify the hyperlink physical implementation information. A WYSIWYG or partial display of the expected output can be provided to assist and guide the user during this procedure. Step 108 may be repeated in a loop or loops with other steps as indicated in Fig. 2, passing control via paths 117 or 118 to previous steps, as the user or as the method of the invention decide are necessary. Equivalent implementations may combine step 108 with one or more steps, for instance, steps 105 and/or 106, and/or 107, to provide a combined operation to the user and also to possibly provide more related information at one point to allow better automatic control within the invention's processes. Step 108 may also occur at a different point in the procedure of Fig. 2, including at an earlier point, where it may be used to constrain other processes, such as that in steps 105, 106 or 107, for instance.

An example of this optional implementation may include where step 108 precedes step 107 and step 108 constrains the hyperlink physical implementation or implementations, by automatic or manual means or both, so that decisions made in the following step 107 are constrained by this predetermined implementation or implementations to, for instance, determine, or partially determine implicitly or explicitly the highlighting, printing or other identification or presentation means of hyperlinks within one page or within a collection of possibly associated pages.

Step 109 involves the final processing of all input data, user options, selections, variables, for producing or describing the expected output document or result, typically, in some digital file format or equivalent construction. The file format

is configured to be ready for execution or implementation by a device or devices arranged to perform the physical rendering, printing, cutting or other physical processes seen in step 110, -required to achieve the output document creation, or intended result, for example using the printer 64 of Fig. 10.

5 Fig. 12 shows the various steps that are implemented in the preferred embodiment for instructing and controlling the physical reproduction system, typically including and printing and/or cutting device, such as those described above for example.

10 Step 109 commences with a sub-step 170 which actions the creation or rendering of document and hyperlink components into suitable file or data format(s) required or expected by printer or printer sub-device. This for example may include formatting using a page description language (PDL) or some file format such as POSTSCRIPT (registered trade mark) for example. This may include any set of instructions or data suitable for reproduction on a printer device, as known in the art.

15 Step 172 follows step 170 and actions the creation or rendering of a cutting template or equivalent graphic for hyperlink cutouts into suitable file or data format(s) as required or expected by cutter or cutter sub-device. This, for example, may include formatting instructions and data suitable for interpretation by the *FC3100-60 Cutting Plotter* described above.

20 Further, as mentioned above, where the printer and cutter are unitarily formed as a single unit, such as the *Fargo Imprensa* mentioned above, steps 170 and 172 may be implemented simultaneously or alternatively as a single step appropriate for the corresponding reproduction environment. Still further, steps 170 and 172 may be swapped in processing order where such are separate functions.

25 Step 176 follows and provides for the optional concatenation, referencing or inclusion of cutter data within printer data or vice-versa as required or expected by cutter-printer devices. Such may be appropriate where the printer and cutter are unitarily formed and respond to a common series of instructions and/or data, but the individual printer and cutting data are separately developed.

Finally, step 178 actions the transmission of the separate or combined printer and cutter data to the printer and cutter device(s) as appropriate and control of those device(s) as required to implement printing and cutting operations respectively. In practice, where separate printing and cutting devices are used, one may follow the other
5 in an automated "production line" fashion. Alternatively, printing and cutting operations may be performed essentially asynchronously. Such could apply to the implementation where the sheets of paper are printed as a large patch, and subsequently the printed sheets are supplied to the cutter, such as the *FC3100-60 Cutting Plotter*.

The resulting physical document may include physical hyperlinks in patterns
10 not dissimilar to the example shown in Fig. 9. In this example, four separate leaves 310, 320, 330, 340 are bound together and overlaid in sequential order with leaf 310 on top followed by leaf 320, leaf 330 and leaf 340 on the bottom. The leaves are shown slightly horizontally offset in Fig. 9 to aid description of the hyperlinked physical document. Hyperlink 302 may represent a typical physical hyperlink of the
15 finger-hole type in which a hole is cut or punched or otherwise manufactured in several consecutive leaves of the document with the destination leaf or page 340, not containing such a finger-hole, but retaining its surface for grasping by the user to aid in direct opening of the destination leaf or page indicated by hyperlink 302. In such an embodiment of a physical hyperlink, the surface of leaf or page 340 which is visible
20 through the finger-hole hyperlink cut-out 302, may be highlighted, printed or otherwise decorated, featured or annotated to allow indication of some detail of the hyperlink or otherwise to aid in clarity or identification or some similar attribute useful to the user. In this embodiment of a hyperlink, 302, the destination leaf or page 340, is accessible from any of the leaves or pages, 310, 320, 330, which include the finger-hole cutout
25 aligned and contiguous with all leaves up to 340. Such an embodiment may be applicable to single-sided documents in which one leaf contains only one printed page, or in double-sided documents in which one leaf may contain two pages, typically one page on each side of a leaf. The method of implementing physical hyperlinks may be, if necessary, adjusted to suit either document type, in which case the terms leaf and

page may be interchanged as appropriate in the preceding and following descriptions to describe hyperlink implementations in either single-sided or double-sided documents or some combination of both.

Another embodiment of a hyperlink is also shown in Fig. 9 as hyperlink 301 in which a reversed implementation is employed to allow hyperlinking from the rear of a document towards the front. Traditionally, documents are read in one direction or are presented as having a single direction of progression or may typically be presented with a heading or first page in a conventional directional relationship to a last or final page. This relationship may differ between cultures or countries but is typically standard in any locale and/or written language. The addition of physical hyperlinks allows non-linear access to a document and therefore releases the user from progressive or linear reading of an entire document, document section or part or page or part page, in one direction. Thus, hyperlinks of type 301 and 302 in Fig. 9 together allow any physical hyperlinked document to be accessed in any direction the author desired and also, within the constraints authored, within the document, permit the user to access the document's contents with greater freedom, more direct control, quickly, and with less ambiguity by actively encouraging and enabling the immediate or direct following of references or hyperlinks encountered or sought within the document.

Fig. 9 also shows another embodiment of physical hyperlinking in which two different hyperlinks, each with its own destination, are stacked atop each other without interference. This embodiment may typically be employed where one or more hyperlinks do not require access from any or all pages of a document but which may have a localised access or reference point. For instance, hyperlink finger-hole 304 in page 320 allows reverse access to page 310. This example shows that page 310 is only accessible through this particular hyperlink, 304, from page 320. Similarly, hyperlink 303 in page 340 allows reverse access to page 330, but only from page 340. Since one or more full leaves or pages lie between these hyperlinks, where the leaves or pages are themselves devoid of hyperlinks or other potentially interfering elements in the two-dimensional page-coordinate region of hyperlinks 303 and 304, then it is

possible to overlap hyperlinks 303 and 304 without interference between their functions or without confusion as to their operation or association or intent. Other similar or analogous arrangements, groupings, associations or overlaying of hyperlinks, of many different physical implementations are possible, each with its own rules or constraints or conditions.

The ability of the user to modify the document and referential link generation process in the manner described above affords substantial utility in producing documents, either in electronic or hard copy form that are tailored to the specific tastes of the author/user. For example, with a fully automated implementation there exists a 1:1 relationship between the hyperlinks in the source document(s) and the referential links in the hard copy reproducible document. However, with user intervention, referential links automatically created may be disabled (a 1:0 relationship) thus avoiding the creation of links that may not be desired. Further, the user may create their own links, thus providing for, in a generic sense, an M:N relationship, where $M \geq 0$ and $N \geq 1$, M and N each being integers. Such may impact upon the specific implementation of the preferred embodiment since HTML only allows a hyperlink to point to one site, usually identified by a universal resource location (URL). In contrast, XML provides for a link to point to a range of URL's. This permits the preferred embodiment the ability to group together hyperlinks according to some grouping criteria such as style and content for example. The grouping may then provide for the referential links in the hard copy reproducible document to be formed in a like fashion, for example using the same colour, or by positioning cut-out and tabs in some form of associated, by nesting for example.

The identification of various hyperlinks within electronic documents, particularly those available within computer networks such as the World Wide Web, can sometimes lead to problems of accessing the corresponding information residing at the identified location. This occurs for example where a document at one Web-site references something residing at another Web-site. Because of the temporal nature of the WWW, it occasionally transpires that the referenced location no longer exists, or

that no information resides at the referenced location (a so-called "dead end URL"). In these situations, the preferred embodiment is configured to identify such a situation and not attempt to create a corresponding functional link within the locally generated document. However, the preferred embodiment may retain such references in a fashion
5 complementing prior art techniques, for example as a listing at the end of the document, or as a footnote within the document. This avoids localized document being generated including erroneous or unnecessary functional links whilst retaining the raw information relating to the hyperlinks within the document. Such processing finds ready application where the referenced URL accesses data other than text or image data
10 readily reproducible in hard copy form, such as audio data, video data, or an executable program to name but a few. The same procedure can be applied to those valid hyperlinks that are not desired to be retained as functional links (ie: the 1:0 cases noted above).

In addition to the described embodiments, the invention may be partially or
15 wholly applied to producing any non-physical or virtual representation of a physical document or page. For instance a physical hyperlinked document may be represented in a visual manner on a display device, such as the display 65 of Fig. 10, while no actual physical document exists. The virtual representation of the physical hyperlinked document may include physical hyperlinks, such as tabs or finger-holes which operate
20 equivalently in the virtual representation to the real, physical implementation of the same features in a real, physical hyperlinked document. For example, the virtual representation of the physically hyperlinked document may provide touch-screen or equivalent functionality which permits the user to place a finger or to otherwise effect a touch signal or mouse-click or key-press or equivalent signal to a virtual representation
25 of a hyperlink tab or finger-hole or equivalent feature. The virtual representation of the hyperlinked document may then effect an equivalent operation to that expected in a physical hyperlinked document, that being a single or multiple page turn operation as controlled by the parameters embodied in the hyperlink activated by the user. Preferably, such functionality is afforded whenever the WYSIWYG representation of

the document is utilized in the embodiments described above. Significantly, during document creation, this can afford the author (user) the ability to test the functionality of the virtual hyperlinks as they would be replicated in a physical document, thereby allowing human intervention to sculpt the layout and hyperlinking style of the document.

In a further embodiment, the invention may also be applied to produce compound second documents 40, whether the first document 10, was a compound or single document. The compound second document 40 is produced in such a way as to enable the user to separate out two or more distinct sections which may independently contain their own locally consistent relative hyperlinking functionality as well as external hyperlinks which interconnect the multiple documents when they are reunited in the intended order and format. This feature permits the nesting of printed hyperlinked documents so that the user may remove or separate, so as to make independent, one or more of the nested documents, whilst the hyperlinking functionality is retained internally within the independent documents. The user may choose to reunite the separate documents in the preferred or intended order so that the previously separate documents become interconnected by common and previously established hyperlink functionality. Several methods may be implemented within the previous description of the preferred embodiment of the invention to produce such compound document or documents. One example is to produce the first part of a compound document as a separate document without reference to the second part of the compound document whilst retaining as much information as possible from the process of production of the first part of the compound document and utilizing that information in the production of the second part of the compound document, making reference to the elements, properties, hyperlinks, attributes, user selections and other information from the first part for use in production of the second part. Another example is to process the compound document as one document with additional information possibly provided by the user or interpreted or assumed automatically from input data or from the elements and structure of original document 10, such that each sub-document or part of

the compound document has several features or parameters or attributes isolated from the same or similar features, parameters or attributes within the remainder of the compound document. For instance, the grouping and positioning of physical hyperlinks, and possibly other elements may be made so that an artificial or constructed attribute or property boundary or boundaries may be created or introduced between parts of the same compound document during creation, conversion or processing of the compound document so as to produce a physical compound document. This can then permit subtraction or removal of a part, which removable part is described or identified by the introduced boundary or boundaries. These principles or methods may also be applied as described or iteratively to produce compound documents containing more than two parts or sub-documents. Examples of such compound documents include references having a table of contents, appendices to larger documents and multi-volume documents such as encyclopedia.

Although the above described embodiments refer in general to the generation by a user of a document derived from typically a number of sources accessible via a computer network, the invention is not limited thereto and may be equally applied to a document generated locally, for example on a single personal computer workstation. A further extension of this may include the generation of the user interpretable functional links as part of the document creation process. In this fashion the physically reproducible links may be generated upon the creation of the document content in response to user (author) input.

The foregoing described only a number of embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the spirit and scope of the present invention.

CLAIMS

The Claims defining the invention are as follows:

1. A method of creating a representation of information from at least one electronically accessible source of said information, said information including at least one referential link between first matter in said information and second matter in said information, said method comprising the steps of:

electronically extracting said information from said at least one source;

identifying said referential link to establish a referential path between the first matter and the second matter;

arranging the information as a document in a format suitable for hard copy reproduction in which each of said first matter and said second matter are individually identifiable; and

using said referential path to incorporate into said document and format a user interpretable functional link between the first matter and the second matter.

2. A method according to claim 1, wherein the functional link comprises an observable device that refers the user from the first matter to the second matter, said device being incorporated into said format in addition to said information.

3. A method according to claim 2, wherein said device comprises a rendered link coupling the two matters.

4. A method according to claim 2 or 3, wherein said device comprises a portion on a first display page that provides a link between the first matter on said first display page and the second matter on a second display page.

5. A method according to any one of the preceding claims, comprising the further step of displaying said document using a hard copy reproduction device.

6. A method according to claims 5, wherein the information is arranged for display by printing on a medium and said functional link is printed onto said medium.

7. A method according to claim 6 when dependent on claim 4, wherein said
5 portion comprises a physical alteration to said medium.

8. A method according to claim 7, wherein said portion comprises a cutout in the medium.

10 9. A method according to claim 7, wherein said portion comprises a tab attached to the medium.

10. A method according to any one of claims 1 to 4, comprising the further step of displaying said document on a display screen.

15 11. A method according to claim 10, wherein said functional link comprises selectable portions that emulate a hard copy reproduction of said document.

20 12. A method according to claim 11, wherein said portion comprises an icon incorporated in the display of said document manipulable to transverse the displayed document from the first matter to the second matter.

13. A method according to claim 1, wherein said first and second matter comprise corresponding first and second locations within said information.

25 14. A method according to claim 1, wherein said first and second matter comprise corresponding first and second content within said information.

15. A method according to claim 1, wherein said referential link comprises a hyperlink between the two matters.

16. A method according to claim 15, wherein said information is sourced as data from a data network and said hyperlink represents a virtual path interconnecting the first matter with the second matter via the data network.

17. A method according to claim 1, wherein said referential path is updated and maintained whilst the information is being arranged into said format.

18. A method according to claim 17, wherein said format comprises at least one displayable page for reproducing the information and said referential path comprises a mapping between the first matter and the second matter as those matters are reproducible on said at least one displayable page.

19. A displayable document comprising information for hard copy reproduction, said information including a identifiable first link between first matter within said document and second matter within said document, characterised by a functional second link referring from the first matter to the second matter, said functional second link being formed using a association between the first matter and the second matter reproduced in a user interpretable manner in said document.

20. A document according to claim 19, wherein said functional second link visually and/or physically refers the user from the first matter to the second matter.

21. A document according to claim 20, wherein the visual reference comprises a rendered link in the hard copy reproduced document coupling the first matter with the second matter.

22. A document according to claim 20 or 21, wherein the physical reference comprises a physical alteration of the medium upon which the document is reproduced.

23. A computer readable medium having encoded thereon a linearly arranged physically reproducible document including at least one hyperlink between first matter and second matter, said link forming in said document when reproduced a user interpretable path coupling said first matter with said second matter.

24. A computer readable medium, wherein said medium is selected from the group consisting of a magnetic disk device, an optical disk device, a tape device and a computer network.

25. A document creation system including:

means for accessing electronic information intended for reproduction, the information including at least one hyperlink;

means for information as a contiguous localized document in a reproducible format;

means for incorporating into said localized document at least one functional links related to said at least one hyperlink, said at least one functional link being reproducible in said localized document for replicating function associated with said at least one hyperlinks; and

means for displaying the localized document.

26. A system according to claim 25 wherein each said functional link includes indicia, reproducible in a material form to replicate, upon interpretation of said localized document, said at least one hyperlink.

276. A system according to claim 25, wherein said localized document - is configured for hard copy reproduction by printing.

28. A system according to claim 25 wherein said means for displaying comprises a printer for reproducing said localized document on a recording medium, said printer being associated with means for creating said indicia with said recording medium .

5 29. A system according to claim 25 wherein said means for displaying comprises a video display upon which said localized document incorporating said indicia can be at least viewed.

30. A system according to claim 29 wherein associated with said video display is a traversal means for traversing said localised document via said indicia to functionally replicate said at least one hyperlink.

31. A system according to claim 28 wherein said indicia are selected from the group consisting of a line printed on said medium, a symbol printed on said medium, a cut-out portion of said medium, and a tag applied to said medium.

32. A system according to claim 25, wherein said means for incorporating comprises means for converting referential links in said accessed information into physically reproducible links within said localized document.

33. A non-linear access method for a hard copy document, said document comprising linearly arranged information and at least one link physically incorporated in said document and coupling first matter in said information with second matter, said method comprising the steps of:

25 observing a reproduction of said first matter in said information distinguishable from other of said information; and

tracing a physical indicia in said document distinguishable from said information from said first matter to identify said second matter.

34. A method according to claim 33, wherein said physical indicia comprises a line printed on said document and coupling said first matter with said second matter; and said tracing comprises following said line.

5 35. A method according to claim 33 or 34, wherein said physical indicia comprises a physical alteration to one of a plurality of a pages of said document, and said tracing comprises using said alteration to traverse from said one page comprising said first matter to another page comprising said second matter.

10 36. A method according to claim 1, comprising the step of preserving original referential links in said document using said functional link to provide a non-linear means for accessing said matter within said (linear) document.

15 37. A method according to claim 1, comprising the step of creating a sequential document from said extracted information and inserting into said sequential document at least one non-sequential link between said first matter and said second matter.

20 38. A method according to claim 8 wherein said document comprises a plurality of said cutouts, at least two of said cutouts being nested at corresponding locations on different pages of said document.

25 39. A method according to claim 2 wherein observable devices of one functional link are reproducible in a first colour scheme and observable devices of another functional link are reproducible in a second colour scheme different from the first colour scheme.

40. A system according to claim 28 wherein said printer and said means for creating said indicia are unitarily formed.

41. A computer program product comprising a computer readable medium incorporating a series of instructions interpretable by a computer for creating a document, said computer program product including:

a first module for accessing electronic information intended for reproduction,
5 the information including at least one hyperlink;

a second module for formatting the accessed information as a contiguous localized document in a reproducible format;

a third module for incorporating into said localized document at least one functional link related to said at least one hyperlink, said at least one functional link
10 being reproducible in said localized document for replicating a function associated with said at least one hyperlink; and

a fourth module for displaying the localized document.

42. A computer program product according to claim 41 wherein each said
15 functional link includes indicia, reproducible in a material form to replicate, upon interpretation of said localized document, said at least one hyperlink.

43. A computer program product according to claim 41, wherein said localized document is configured for hard copy reproduction by printing and said fourth module
20 includes instructions for controlling a printer for reproducing said localized document on a recording medium,.

44. A computer program product according to claim 42 wherein said fourth module including instructions for creating said indicia with said recording medium.

25 45. A computer program product according to claim 42 wherein said means for displaying comprises a video display upon which said localized document incorporating said indicia can be at least viewed and said fourth module includes instructions for

traversing said localised document via said indicia to functionally replicate said at least one hyperlink.

46. A computer program product according to claim 41 wherein said indicia are selected from the group consisting of a line printed on said medium, a symbol printed on said medium, a cut-out portion of said medium, and a tag applied to said medium.

47. A computer program product according to claim 41, wherein said third module includes instructions for converting referential links in said accessed information into physically reproducible links within said localized document.

48. A computer program product according to claim 41 wherein said first module includes instructions for accessing said information from a plurality of non-linear sources via a computer network, the sources including hyperlinks connecting one another, and said second module includes instructions for formatting said accessed information as said localized document according to predetermined hard copy reproduction criteria within which instructions of said third module are configured to create said functional links.

49. A computer program product according to claim 41 wherein said first module includes instructions for creating said information.

50. A method of creating a representation of information from at least one electronically accessible source of said information, said information including at least one referential link between first matter in said information and second matter in said information, said method comprising the steps of:

deriving said information from said at least one source;

identifying said at least one referential link to establish a respective referential path between the first matter and the second matter;

arranging the information as a document in a format suitable for hard copy reproduction in which each of said first matter and said second matter are identifiable; and

using said referential path to incorporate and format into said document a user interpretable functional link between the first matter and the second matter, the functional link including an observable device that refers the user from the first matter to the second matter, said device being incorporated into said format in addition to said information.

51. A method according to claim 50, wherein said device comprises at least one of:

a rendered link coupling the two matters;

a portion on a first display page that provides a link between the first matter on said first display page and the second matter on a second display page; and

a portion on said second display page that provides a link between the first matter on said first display page and the second matter on the second display page

52. A method according to claim 50 wherein said deriving includes creating said information.

53. A computer system comprising:

input apparatus for interfacing user commands to said system;

a processor device couplable to a computer network from which a plurality of electronic documents are accessible, said documents including one or more hyperlinks, said processor device being configured to operate a computer program in response to said user commands to access selected ones of said documents intended for reproduction, and to format the accessed documents as a contiguous localized document in a hard copy reproducible format, said formatting including incorporating into said localized document functional links related to said hyperlinks, said functional links

being reproducible in a material form in said localized document for replicating functions associated with said hyperlinks; and

a printing device for reproducing said localized document by printing onto a recording medium, said printing device being associated with a further device for forming with said recording medium indicia corresponding to said functional links whereby said indicia are manually accessible using a hard copy reproduction of said localised document to traverse said reproduction in a manner complementing said electronic documents.

54. A computer readable medium incorporating a series of instructions interpretable by a computer for creating a document, said computer readable medium including:

a first module for accessing electronic information intended for reproduction, the information including at least one hyperlink;

a second module for formatting the accessed information as a contiguous localized document in a reproducible format;

a third module for incorporating into said localized document at least one functional link related to said at least one hyperlink, said at least one functional link being reproducible in said localized document for replicating a function associated with said at least one hyperlink; and

a fourth module for displaying the localized document.

55. A computer readable medium according to claim 54 wherein each said functional link includes indicia, reproducible in a material form to replicate, upon interpretation of said localized document, said at least one hyperlink.

56. A computer readable medium according to claim 54, wherein said localized document is configured for hard copy reproduction by printing and said fourth module

includes instructions for controlling a printer for reproducing said localized document on a recording medium,.

57. A computer readable medium according to claim 55 wherein said fourth
5 module including instructions for creating said indicia with said recording medium.

58. A computer readable medium according to claim 55 wherein said means for
displaying comprises a video display upon which said localized document incorporating
said indicia can be at least viewed and said fourth module includes instructions for
10 traversing said localised document via said indicia to functionally replicate said at least
one hyperlink.

59. A computer readable medium according to claim 54 wherein said indicia are
selected from the group consisting of a line printed on said medium, a symbol printed
15 on said medium, a cut-out portion of said medium, and a tag applied to said medium.

60. A computer readable medium according to claim 54, wherein said third module
includes instructions for converting referential links in said accessed information into
physically reproducible links within said localized document.

20

61. A computer readable medium according to claim 54 wherein said first module
includes instructions for accessing said information from a plurality of non-linear
sources via a computer network, the sources including hyperlinks connecting one
another, and said second module includes instructions for formatting said accessed
25 information as said localized document according to predetermined hard copy
reproduction criteria within which instructions of said third module are configured to
create said functional links.

62. A computer readable medium according to claim 54 wherein said first module includes instructions for creating said information.

DATED this SEVENTH day of SEPTEMBER 1998
Canon Kabushiki Kaisha

Patent Attorneys for the Applicant
SPRUSON & FERGUSON

A1-1/14

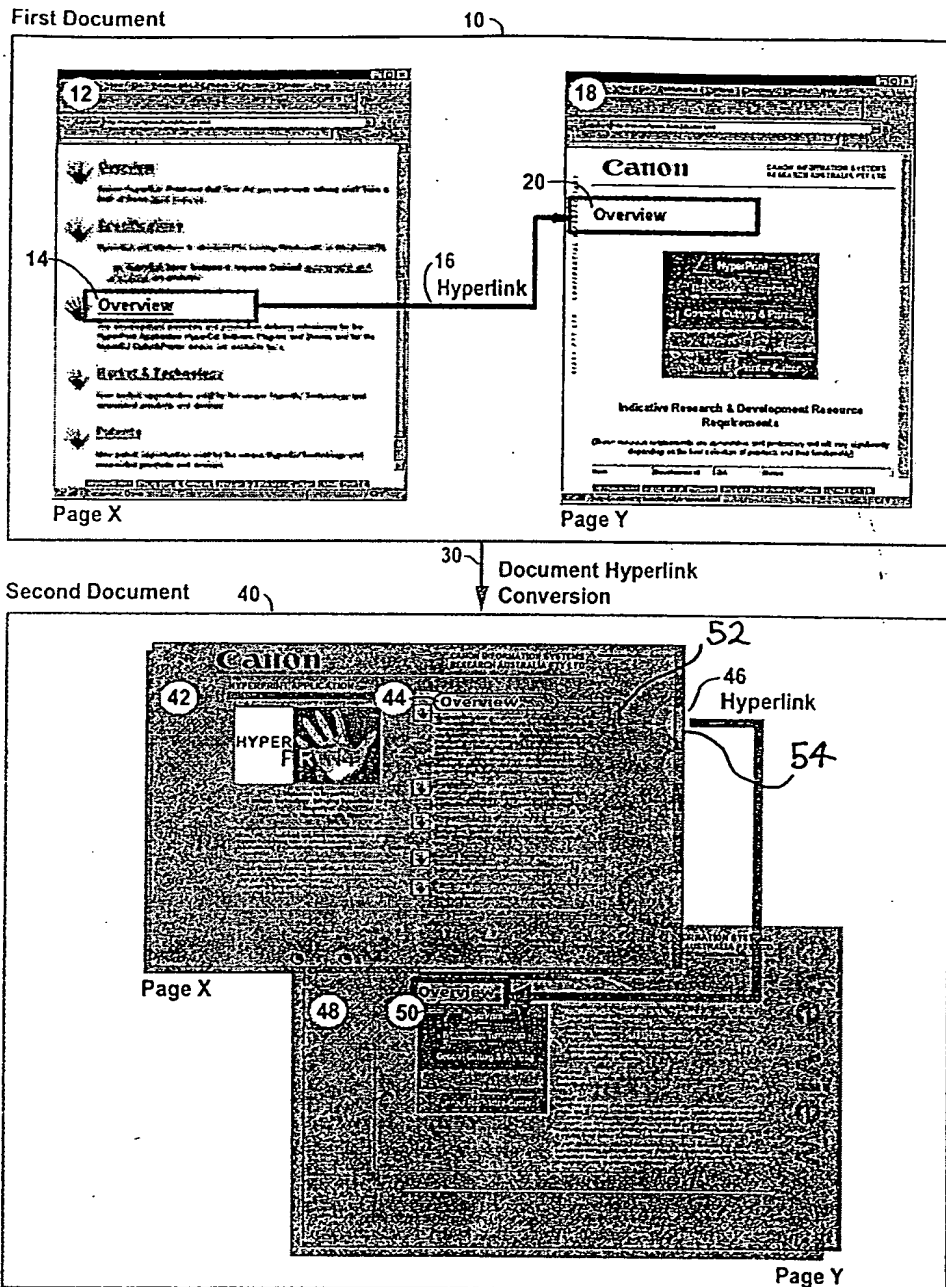


FIG. 1

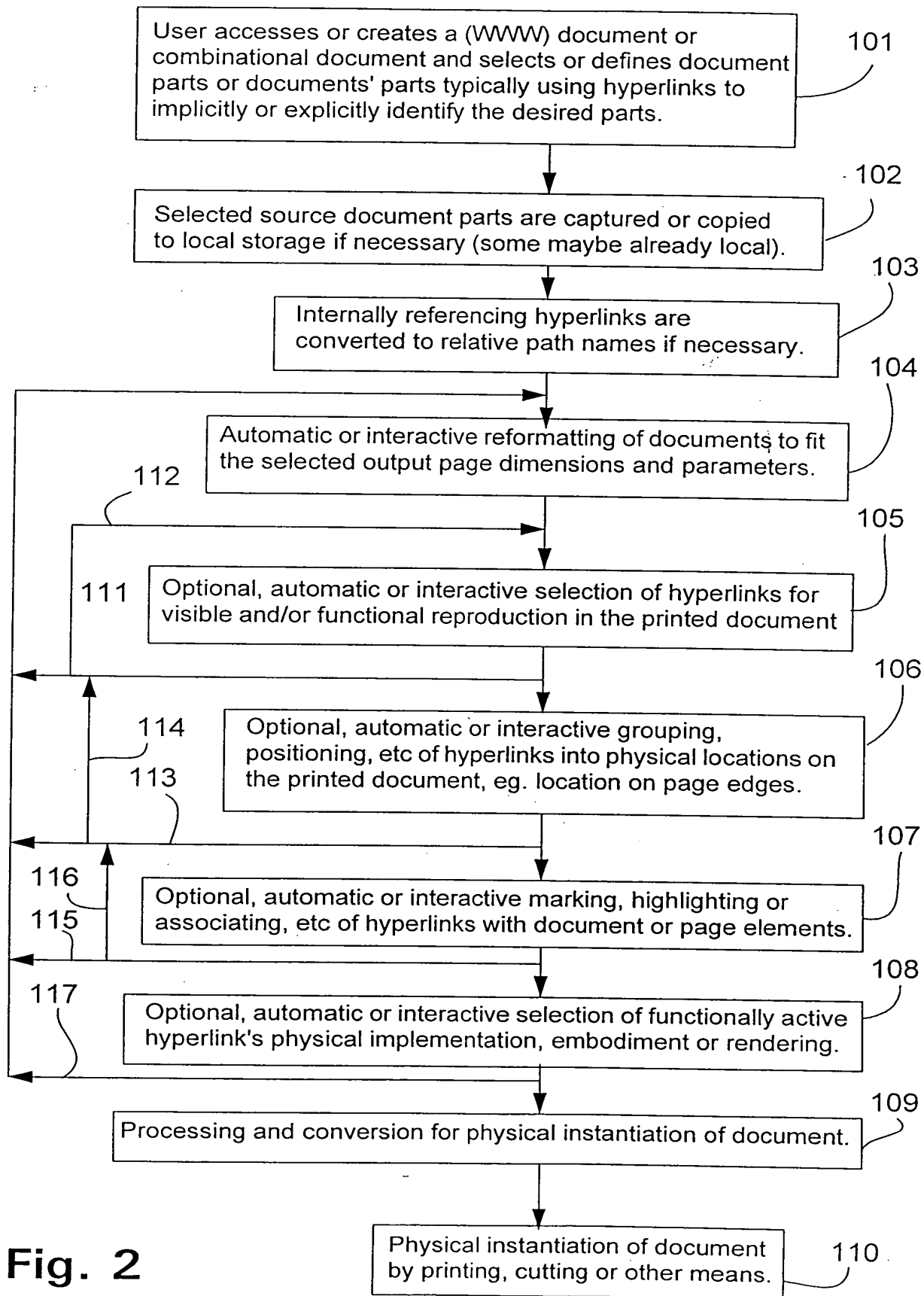


Fig. 2

AI-3/14

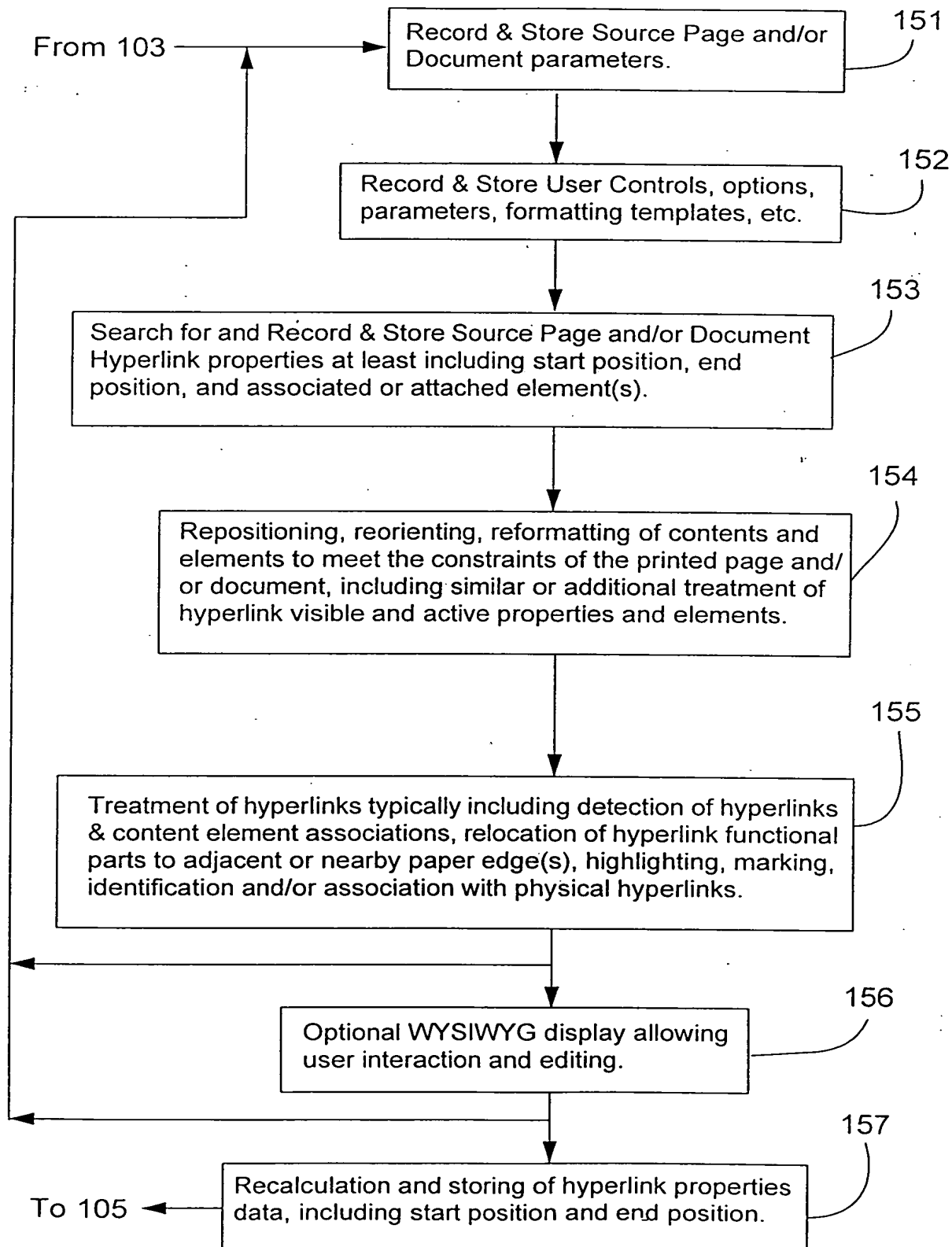


Fig. 3

```
<H1> This text contains a <BR>
<A HREF = "http://www.example.com/index.htm#end">link</A>
to another page. </H1>
<P>Other content...
...
...
...
</P>
...
...

<A NAME = "end"> <H1> Heading Text </H1> </A>

<P> Other content ...
...
...
...
</P>
...
...
```

Fig. 4

Source HTML page or document

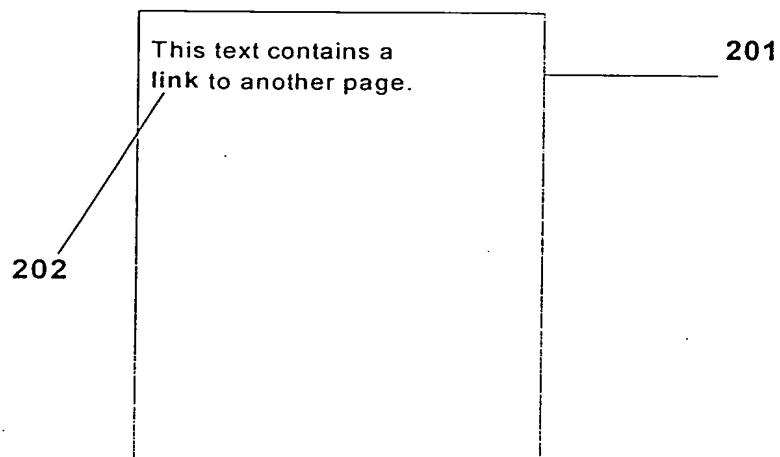


Fig. 5A

Reformatted page or document

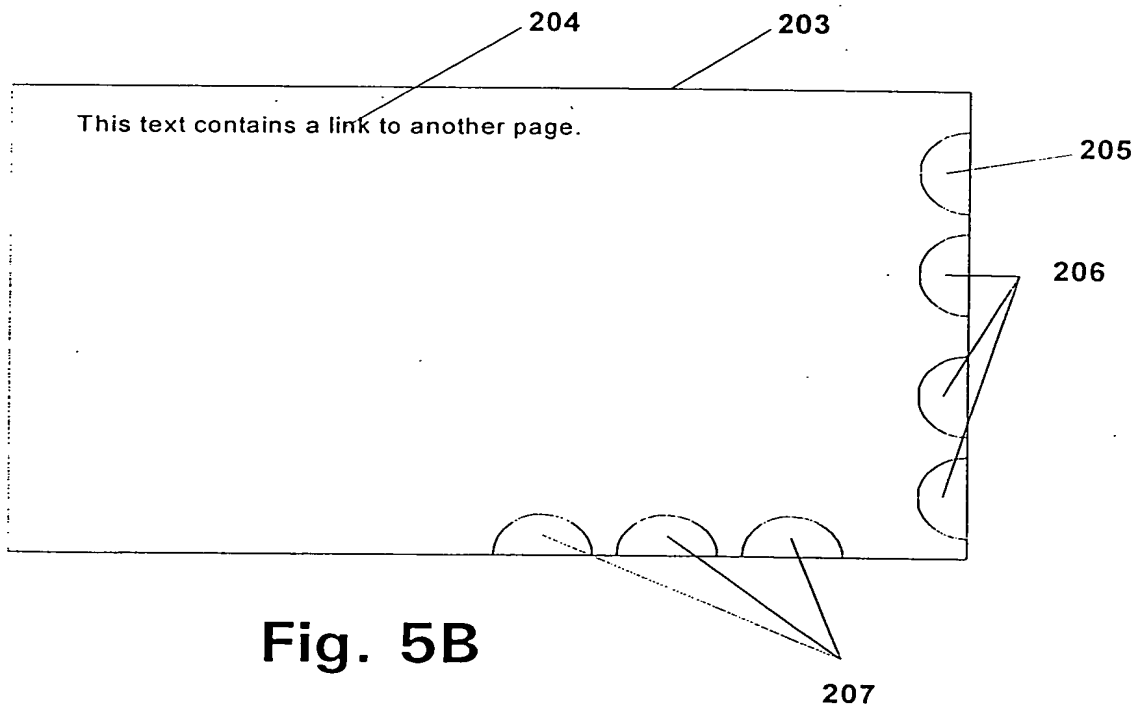


Fig. 5B

```
<A NAME = "end" > <H1 >Heading Text</H1 > </A >
```

```
<P>Other content...
```

```
...
```

```
...
```

```
...
```

```
</P>
```

```
...
```

```
...
```

Fig. 6

Reformatted page or document with various optional associations between visible and active portions of hyperlink.

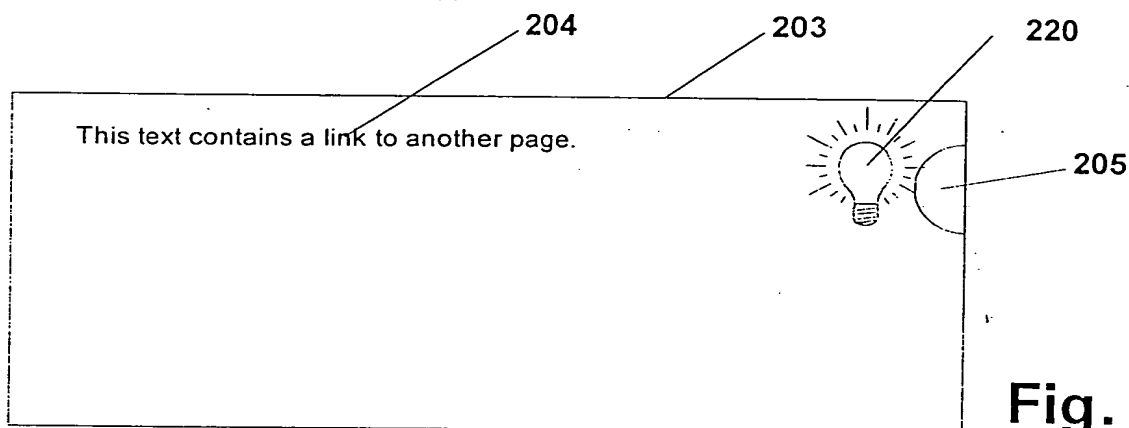


Fig. 7A

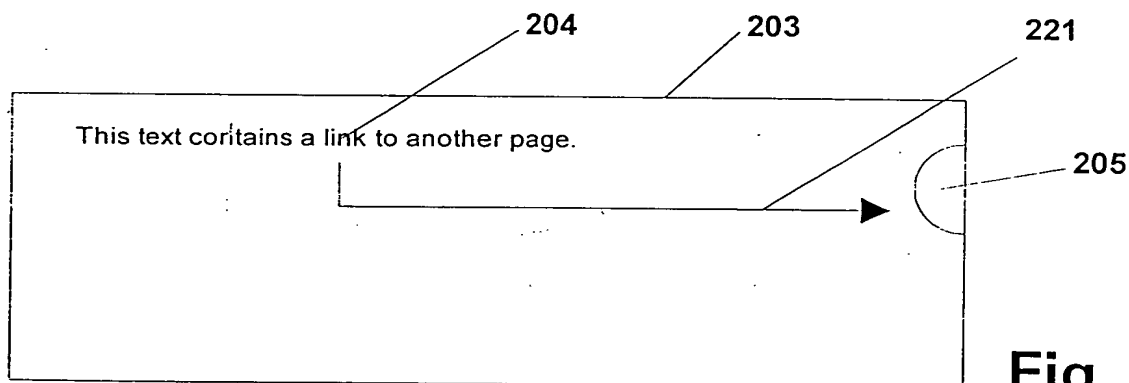


Fig. 7B

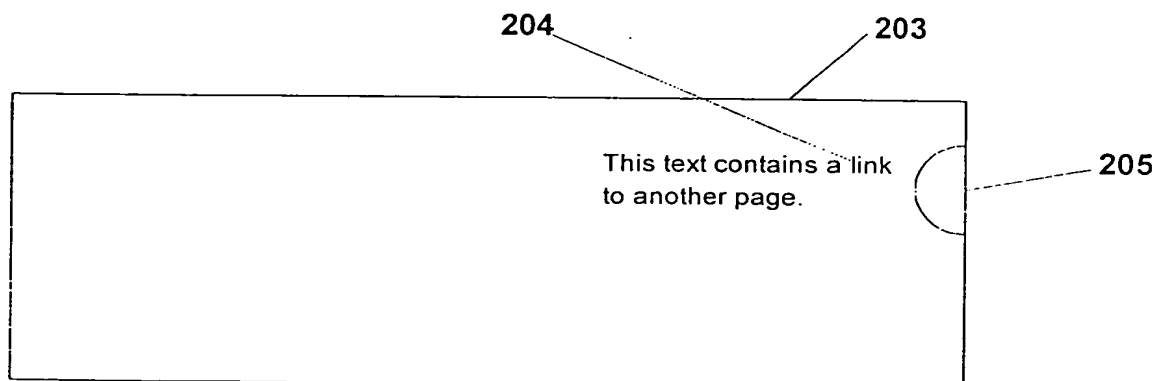


Fig. 7C

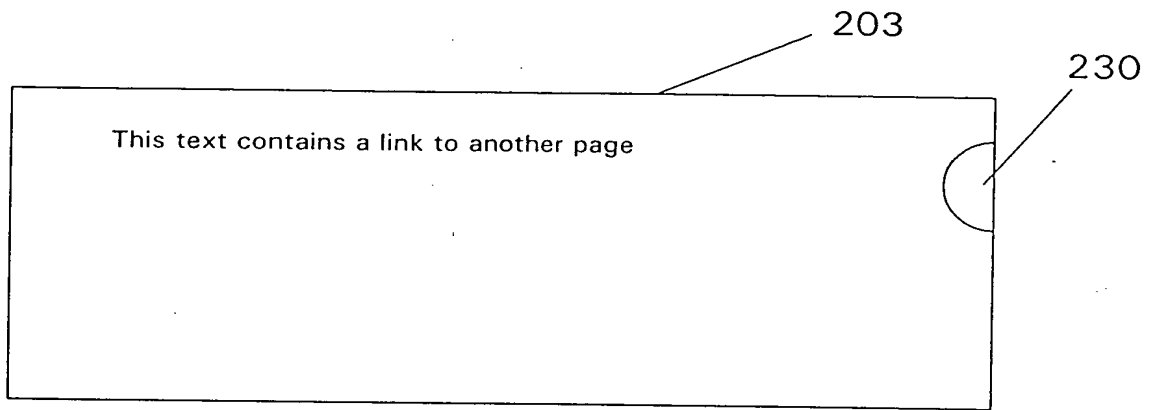


Fig. 8A

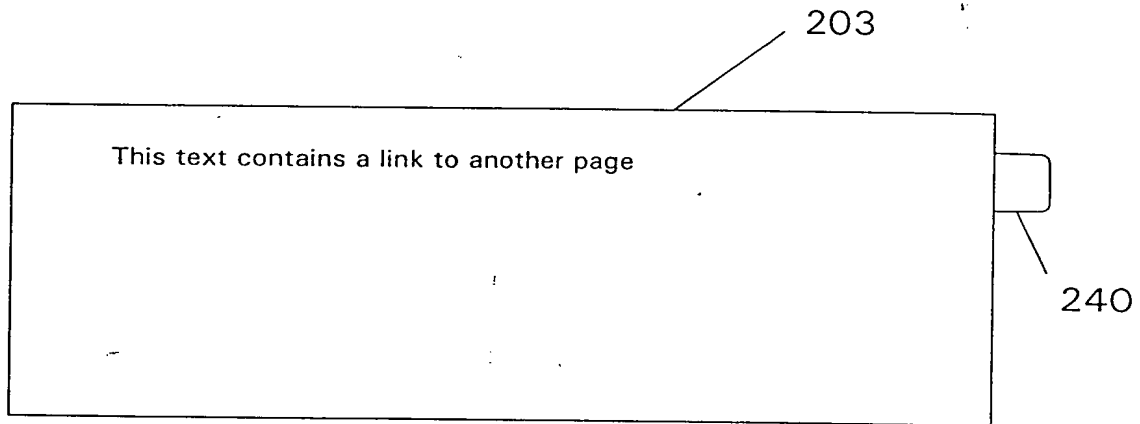


Fig. 8B

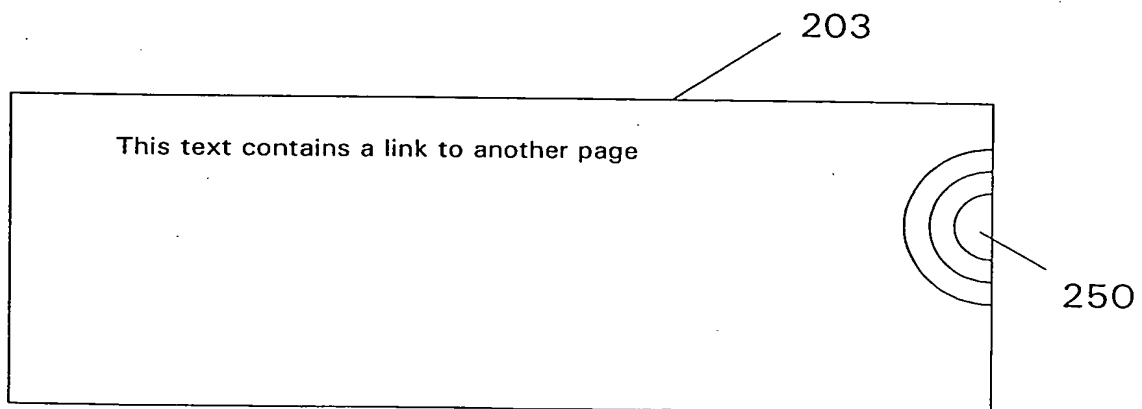


Fig. 8C

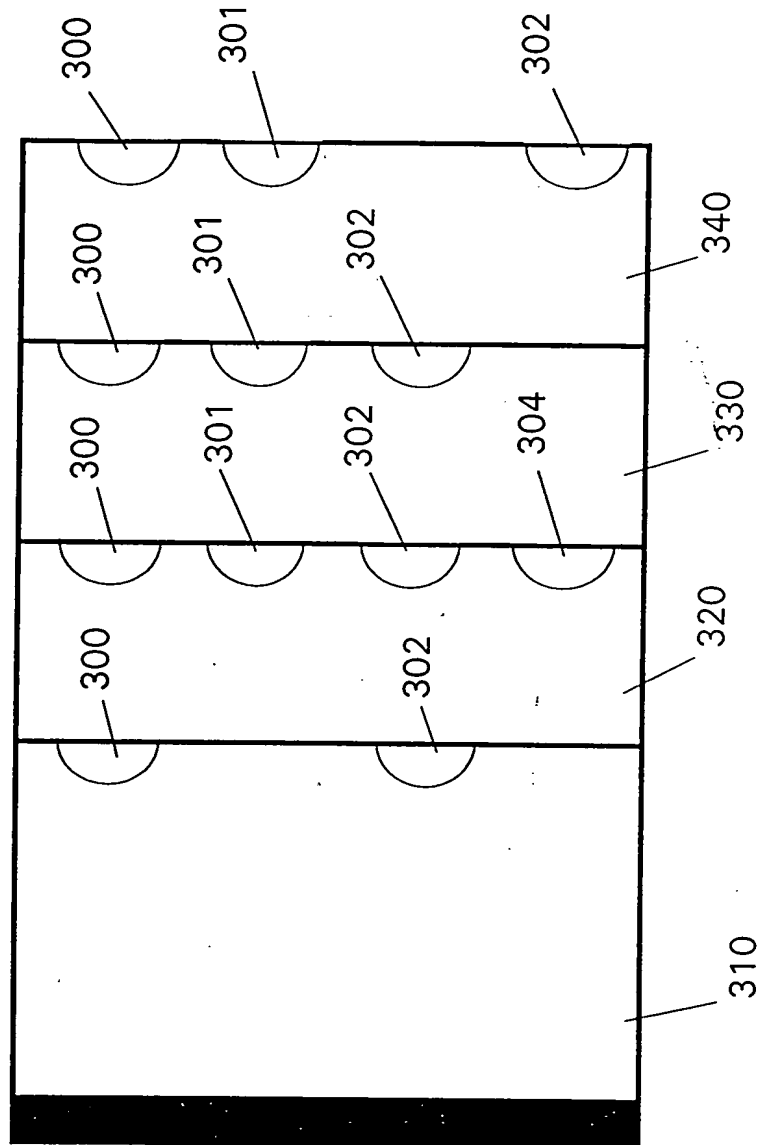


Fig. 9

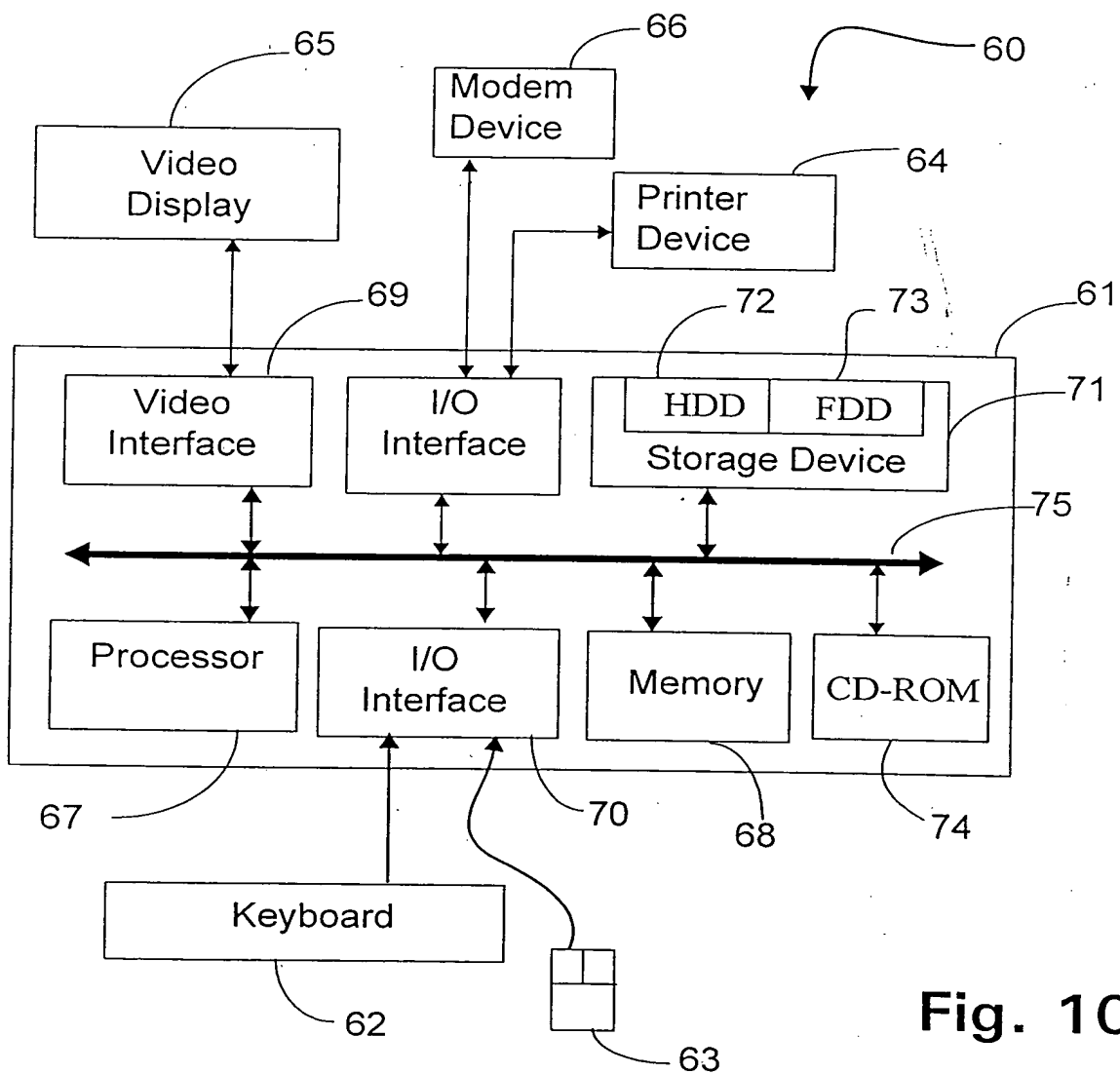


Fig. 10

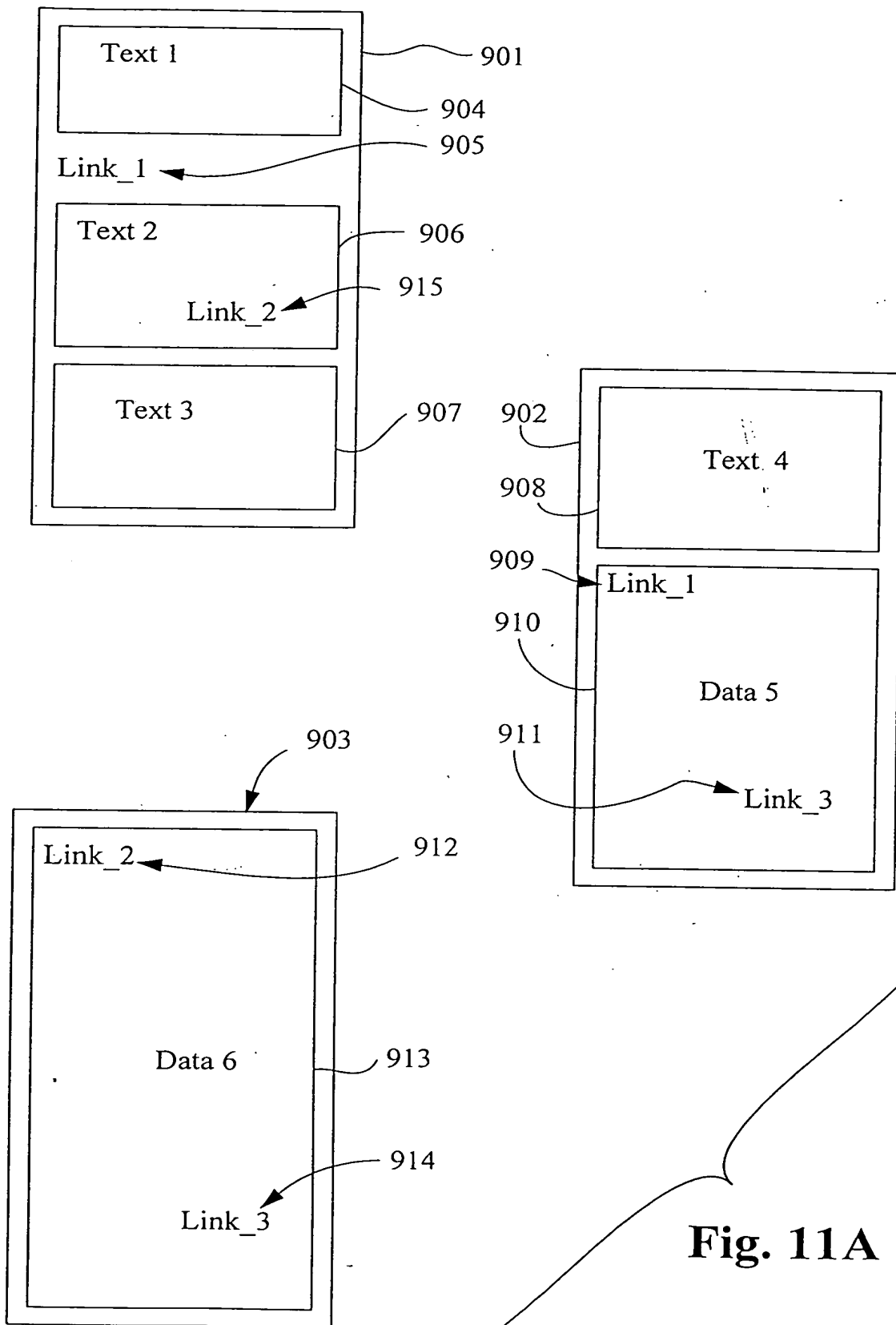
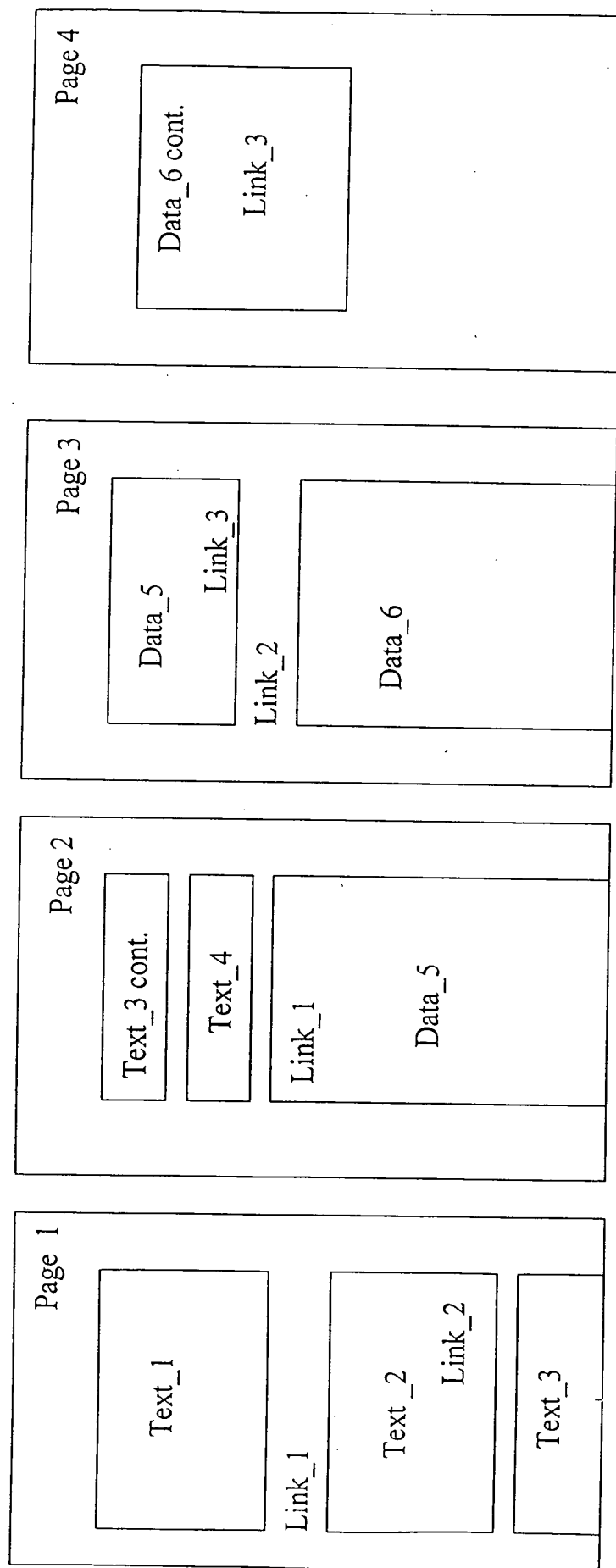


Fig. 11A

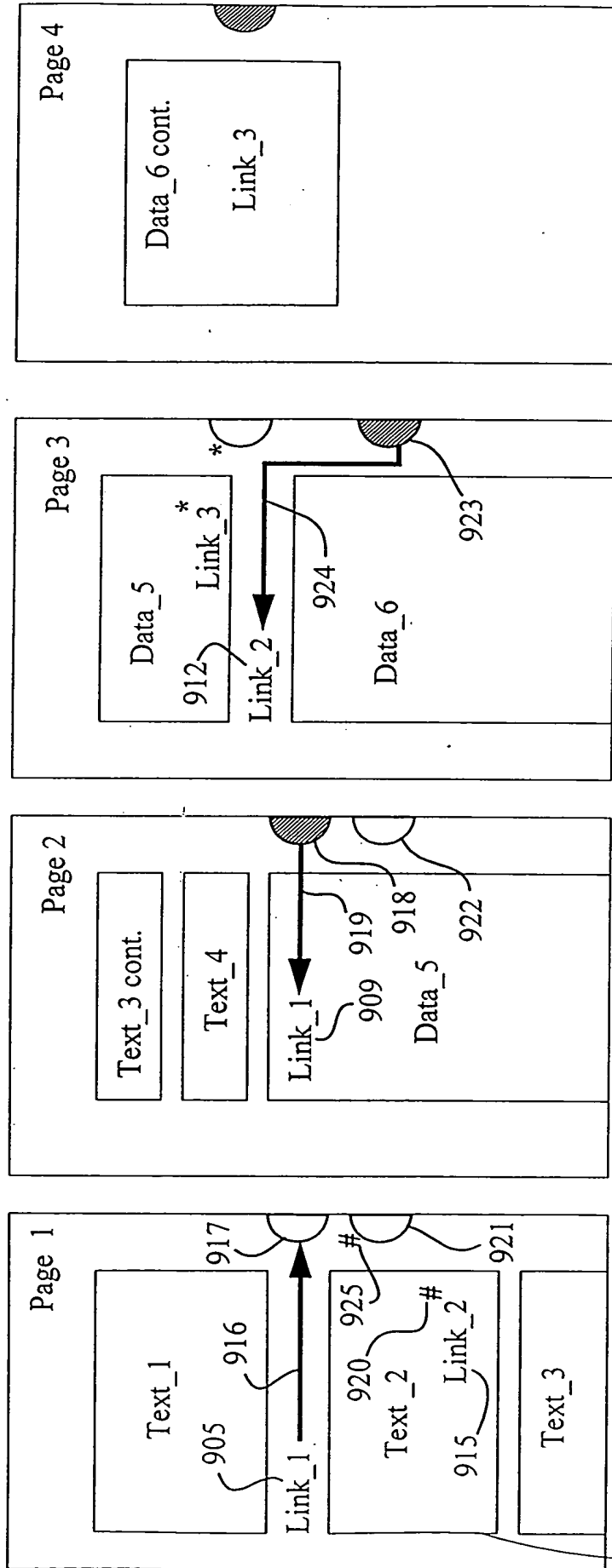
900



A1-12/14

Fig. 11B

900



A113/14

Fig. 11C

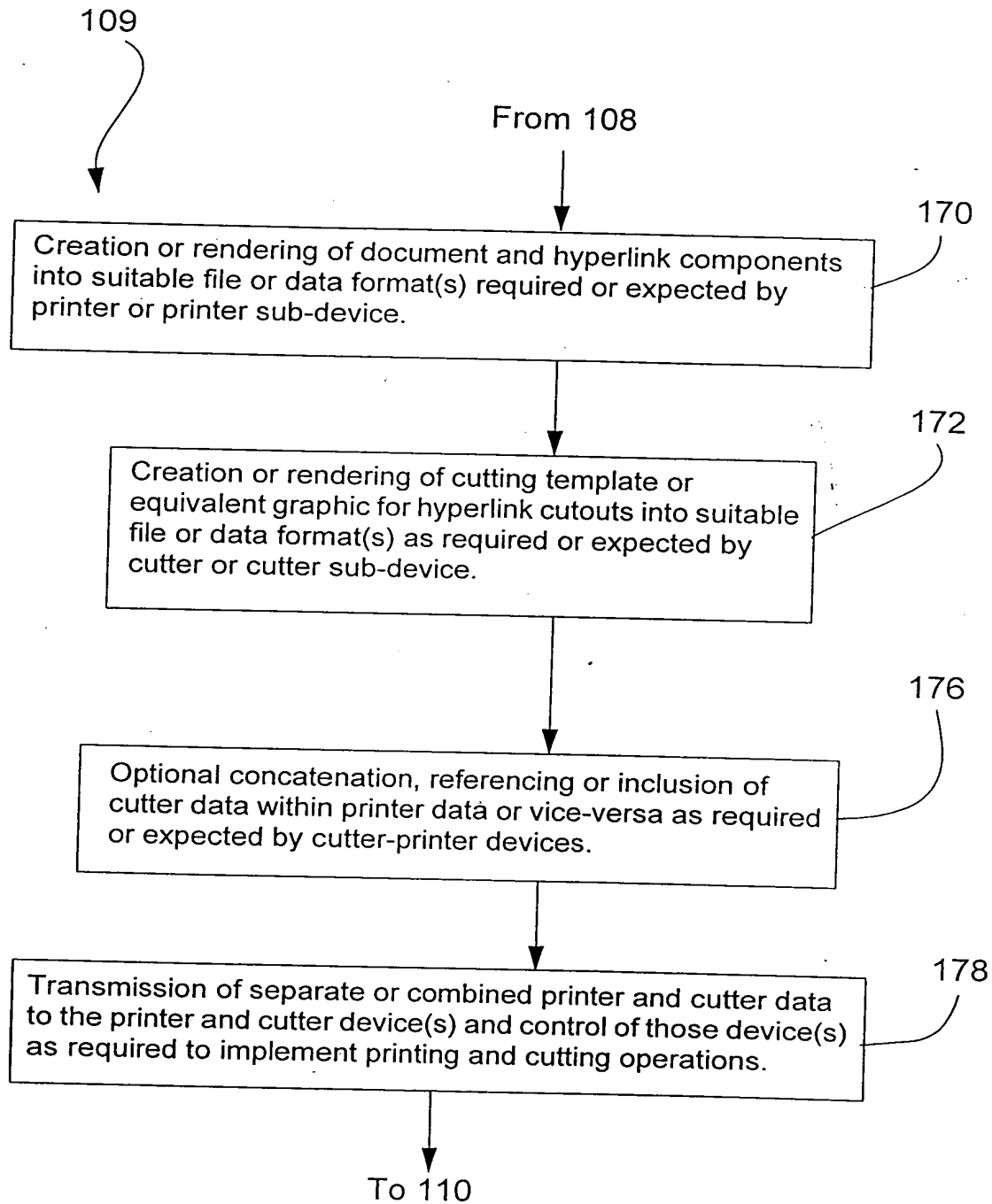


Fig. 12

APPENDIX 2

Retaining Hyperlinks in Printed Hypermedia Document

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ABSTRACT

In this paper, we describe a method that allows a hypermedia document to retain its hyperlinks in the printed copy. The method associates the hyperlinks with cut-out tabs on the edges of the printed pages. A method for modelling the cut-out tabs and optimising their assignment to the hyperlinks is discussed. We also describe a prototype authoring system that implements the method.

Keywords

Hyperlinks, hypermedia documents, printing, cutting, cut-out tab, World Wide Web, HTML, CSS.

INTRODUCTION

Hypermedia documents are computer-based documents that contain text, graphics, audio and video on pages that are connected by navigational links. The navigational links, often referred to as the hyperlinks, permit non-sequential or non-linear traversal of the document by the readers. A well-known source of hypermedia documents is the so-called World Wide Web (WWW) or simply the Web.

Hypermedia documents allow multiple views and efficient, non-linear exploration of information that are not possible with traditional books. On the other hand, the absence of an obvious linear structure and physical elements make it very easy to get lost in the hyperspace.

Hypermedia documents may be printed. Nevertheless, the hyperlinking functionality is typically lost in the printed copy. Most hypermedia documents especially those on the Web are intended for viewing on the screen and designed to exploit the hyperlinking functionality. As a result, readability also suffers with the loss of the hyperlinks. For instance, removing the hyperlink to the definition of an unfamiliar term may make a description unclear to the readers.

Recently, the World Wide Web Consortium (W3C) has included elements in its Cascading Style Sheet Level 2 (CSS2) specification [1] to allow a Web page to have different styles for different output media. For example, different fonts, margins and colors may be specified for screen displaying and printing. Alternatively, a separate document especially designed for printing may be maintained. In this case, readability of the printed copy can be improved by re-organizing those parts of the documents that are affected by the loss of hyperlinks. Currently, no technique is available for preserving hyperlinks and, hence, the ability of non-linear browsing in printed copy.

In this paper, we describe a method that allows a hypermedia document to retain at least some of its hyperlinks in the printed copy. The method associates the hyperlinks with cut-out tabs on the edges of the physical pages. Techniques for presenting such association visually are discussed. It is obvious that the number of cut-out tabs and thus hyperlinks is limited by the physical dimensions of the pages. Methods for preserving edge space are described. We also present a method for modelling the cut-out tabs and optimising their assignment to the hyperlinks.

CUT-OUT TABS AS PHYSICAL HYPERLINKS

Figure 1 shows two typical examples of cut-out tabs and the terminology we are going to use for describing their various characteristics.

Traditional Use of Cut-out Tabs

Cut-out tabs are sometimes used in traditional books and documents such as dictionaries and operation manuals to facilitate access to the various sections of the document. Cut-out tabs have also been used in some children books to allow non-sequential traversal of the material. The first application provides essentially an indexing function to the content. The later application although more often done for fun than other more subtle practical purpose is nevertheless hyperlinking. Typically, only a small number of cut-out tabs are used and seldom are they vital in delivering the content.

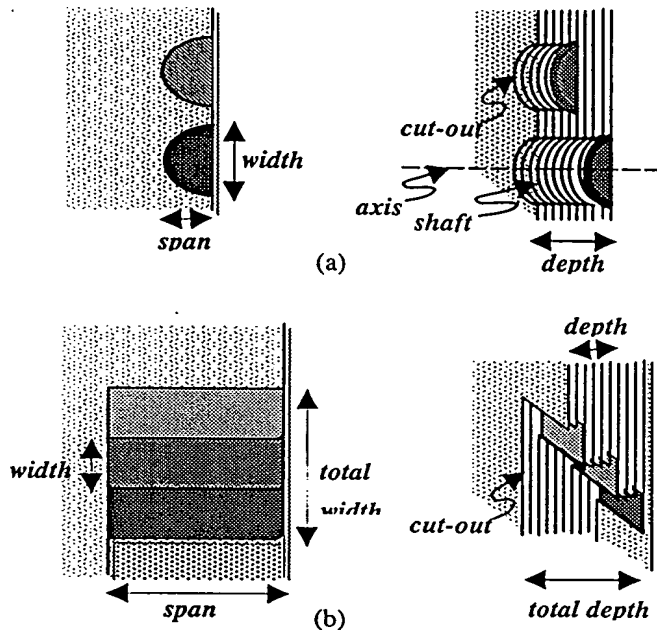


Figure 1: Examples of cut-out tabs.

Hyperlink Support

Cut-out tabs in paper documents and hyperlinks in hypermedia documents are analogous in both their functionality and appearance. When operating a cut-out tab, the reader places a finger or thumb within the cut-out tab, locates the first uncut page surface below the cut-out tab and opens that page. The action is not unlike clicking a hot-spot or anchor - the start point of an hyperlink - in a hypermedia document and traversing to the target page or the end point of the hyperlink (figure 2). In addition, like hot-spots, cut-out tabs are visually distinct from their surround.

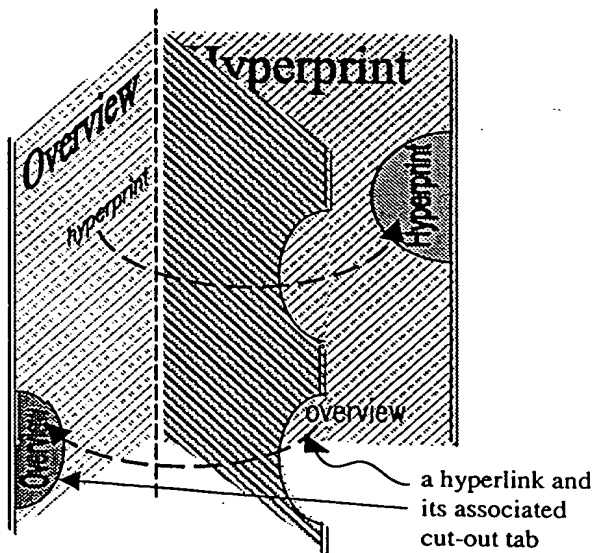


Figure 2: Traversing hyperlinks in printed hypermedia document.

A cut-out allows traversing the document in both the forward and backward direction. A cut-out tab that implements a forward (backward) link from an earlier page to a later page also provides an implicit backward (forward) path from the later page to the earlier page for free. The implicit return path can be used for hyperlinks linking information in the opposite direction. For instance, the two hyperlinks in figure 2 can share the same cut-out as shown in figure 3.

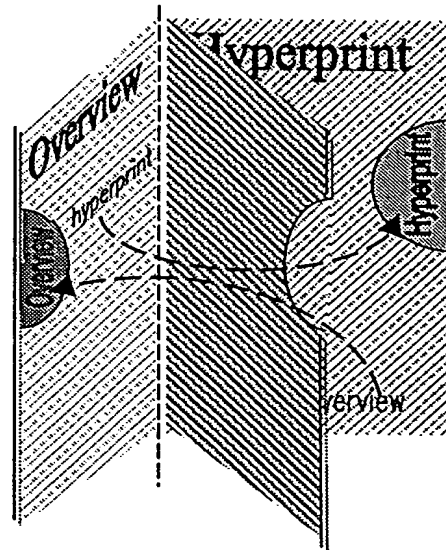


Figure 3: Utilizing both the forward and backward paths of a cut-out tab for hyperlinks in opposite directions.

Styles and Properties

The cut-out reviews part of the linked page. The uncut surface reviewed is usually color-coded or marked with a distinctive pattern or texture. Text label and/or icon can be placed within or alongside the cut-out tab to associate the cut-out tab with a hyperlink (figure 4).

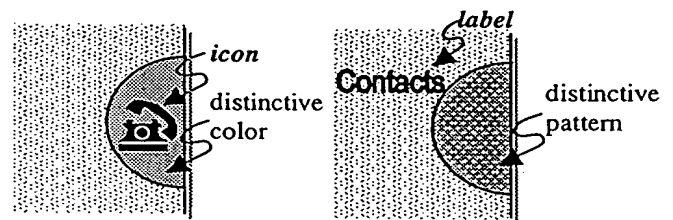


Figure 4: Styles commonly used for cut-out tabs.

Labelling

A cut-out tab is visible to and has an effect on all the pages the cut-out passes through. Placing the label/icon within a cut-out tab have the implication that the hyperlink is relevant to all the intermediate pages. As an example, this type of labelling is suitable for implementing the "home" hyperlink found in many Web pages.

If the label or icon is placed alongside the cut-out tab, the label/icon can be removed or greyed out for those

intermediate pages where the hyperlink is irrelevant (figure 5). By placing the label/icon alongside the cut-out tab, it also allows the cut-out tab to be shared by multiple hyperlinks that end at the same target page. Multiple labels/icons can be placed along side the cut-out tab on a single page (figure 6). In addition, different labels/icons can be used on different pages.

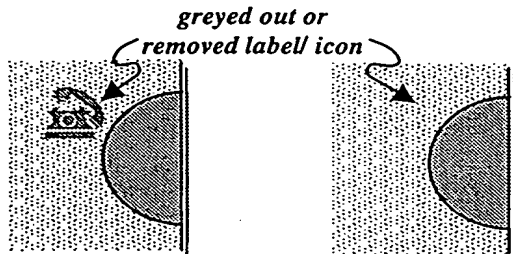


Figure 5: "Disabled" cut-out tabs on pages where the associated hyperlinks are irrelevant.

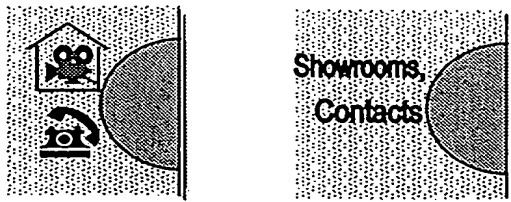


Figure 6: Multiple hyperlinks that end at the same target page can share a cut-out tab by placing multiple labels/icons alongside the tab.

Instead of placing labels/icons alongside the cut-out tab, text or graphical object within the content can be used directly. In this case, a connector is used to connect the text/graphical object to the cut-out tab (figure 7). Coloring scheme or indexing scheme although sometimes hard to decode when used alone, can also be used to associate the hot-spots to the cut-out tabs (figure 8).

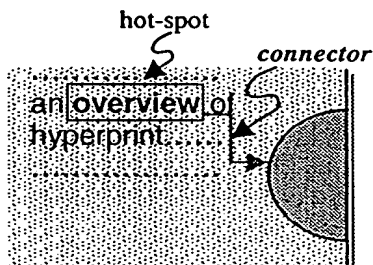


Figure 7: Using connector to associate a hot-spot with a cut-out tab.

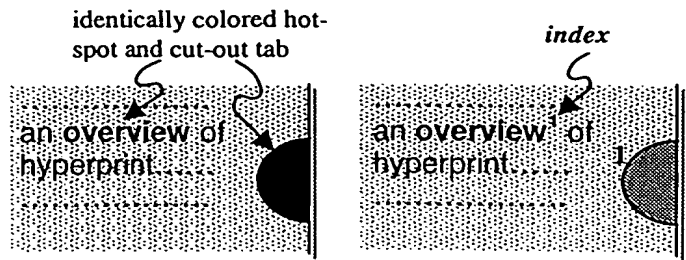


Figure 8: Using color and index to associate hot-spots with cut-out tabs.

Nested Cut-out Tabs

Related hyperlinks can be grouped to form a set of nested cut-out tabs of progressive size along a single axis (figure 9) freeing up edge space for other hyperlinks. However, the resulting nested tabs has a larger total width than that of a single tab. Hence, the saving is not exactly n folds for nesting n cut-out tabs. When using a set of nested cut-out tabs, the user selects which hyperlink to traverse by simply moving the thumb or finger slightly to grasp the desired size of the cut-out. The set of rectangular tabs shown in figure 1(b) can be thought of as a special type of nested cut-out tabs.

It should be stressed that indiscriminate use of nested cut-out tabs may introduce artificial grouping of otherwise unrelated content and confuse the reader. Hence, nested cut-outs should only be used where a natural or logical relationship exists among the linked materials.

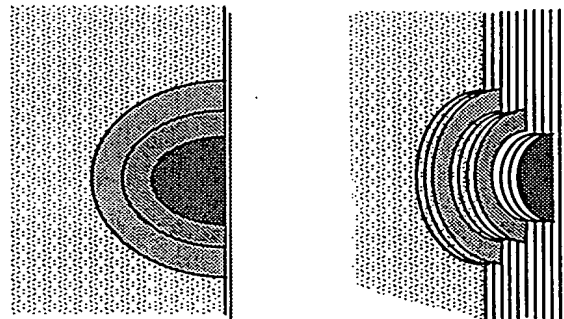


Figure 9: Nested cut-out tabs.

Printing and Cutting

Duplex Printing

Consider a language such as English that reads from left to right, the right edge of the printed hypermedia document will be used for forward links and the left edge for backward links. Backward linking to a right-hand page have to use a cut-out tab that ends at the opposite left-hand page. If the document is printed double-side, then forward linking to a left-hand page also have to be done through a cut-out tab that ends at the opposite right-hand page (figure 10).

There are several implications. First of all, to support backward links, duplex printing is required (for printing the associated cut-out tabs) even if the content is printed only

on one side. Secondly, when referring to the "start/end page" of a tab, we actually imply the start/end page and its opposite page. If the numbering of the pages is known before the optimization process, the conditions for merging the tabs should be relaxed accordingly. Thirdly, in case the content is printed on both sides, clearer means of associating cut-out tabs with hot-spots is especially important as a cut-out tab may become associated with content on the opposite page.

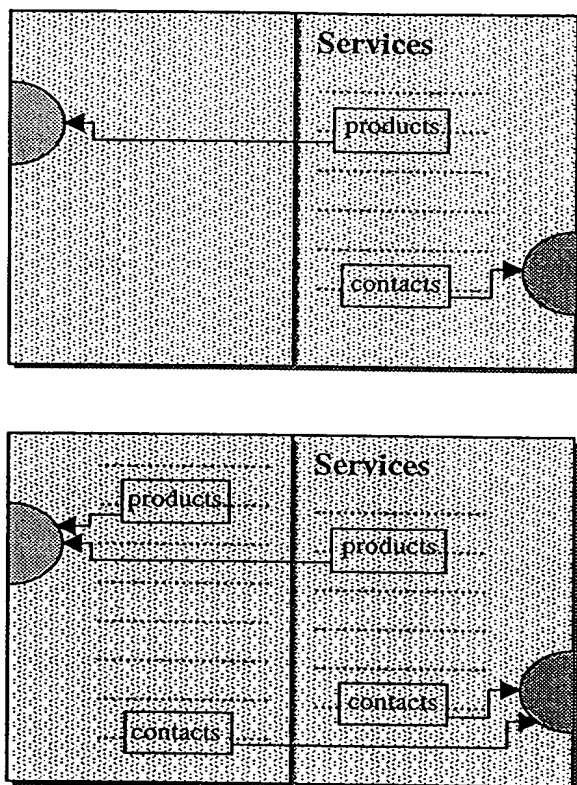


Figure 10: Duplex printing is required to support backward links. Clear association of cut-out tabs and hot-spots is especially important when the content is printed on both side.

Paper Alignment and Color Reproduction

As a cut-out tabs may pass through a number of pages, very precise paper alignment is required of the printer/cutter. In case the hot-spot and cut-out tabs are color coded, the color printer used must be capable of reproducing the color faithfully so that the set of color carefully selected on screen do not become indistinguishable on paper.

MODELLING CUT-OUT TABS AND OPTIMIZATION

Cut-out Tab Model

A physical hyperlink from a hot-spot on page S to a target on page T can be represented by a data structure comprising of the 1-dimensional vector \overrightarrow{ST} and the location of the target page, that is, the page number of T. Since the

cut-out tabs that implement the hyperlink can only be in either a forward or a backward direction, only bi-dimensional vectors are involved. The same basic data structure is used to represent the cut-out tabs each of which may be associated with multiple hyperlinks. Hereafter, depending on context, the notation ST is used to denote a hyperlink or a cut-out tab from page-S to page T.

Additional attributes such as the location of the tabs on an edge, the shape of the tabs, the colours and labels used by the tabs, etc. are required when rendering the tabs. Default values or author's inputs can be used for the value of those attributes that are not set by the optimization process. The author should be allowed to examine the results of the optimization process and make adjustments as required.

As mentioned earlier, a cut-out tab running from S to T has to pass through all the pages in between and is visible - although not necessary required by - those pages. Appropriate presentational style will be used to distinguish an inactive tab from an active one, for instance by removing or greying out the label of a tab when it has no associated hyperlink. An array will be added to the data structure of the cut-out tab to store the status of the tab for the intermediate pages. In case the tab is shared by multiple hyperlinks, a second array will be used to store the labels/icons for the intermediate pages.

The Optimization Process

Overviews

The optimization process starts with a set of cut-out tabs each representing one hyperlink to be implemented physically. The set of cut-out tabs is then gradually reduced by combining cut-out tabs which can serve multiple hyperlinks.

Other physical attributes such as the size of the cut-out tabs and the page as well as certain system parameters such as the edges to be used for tabs, the maximum number of tabs that can be nested along a single axis and the density of the tabs along an edge are required when "optimizing" (in a perceptual sense) the placement of the cut-out tabs.

Graphical Notation

The graphical notations of figure 11 will be used to depict the cut-out tabs diagrammatically. The graphical notations can also be used in the graphical user interface (GUI) of an authoring system or editing tool to visualise the assignment and the physical arrangement of the tabs.

Optimizing the Number of Tabs

The optimization process involves the following basic steps:

1. Define the set of hyperlinks that will be implemented with cut-out tabs.
2. Assign a cut-out tab to each hyperlink.
3. Reduce the number of tabs by sharing the tabs among the hyperlinks.

- Reduce the number of axes by nesting tabs.
5. Reduce the number of axes by aligning non-overlapping tabs.
- In the next section, we will describe the optimization process in greater details using a restaurants guide example.


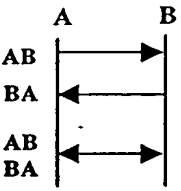
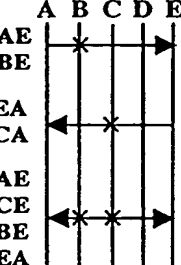
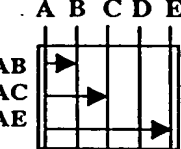
	<p>Section: A vertical bar denotes a section, that is, a set of one or more consecutive pages. The identifiers above the vertical bar denote the end-points of the hyperlinks that start or end at the section, that is, the anchors and targets defined within the section.</p>
	<p>Tab: A cut-out tab is denoted by an arrow. A left pointing arrow represents a forward link and a right pointing arrow represents a backward link. An arrow with arrow head at both ends represents a bi-directional tab that provides both a forward and a backward link. The arrow is labelled. The label indicates the hyperlinks that are associated with the tab. The label has the format ST where S is the identifier of the anchor and T is the identifier of the target.</p>
	<p>Shared tabs: To denote a cut-out tab that is shared by a set of hyperlinks, a cross is placed at the anchor section of each hyperlink except the outermost one along the arrow that represents the tab.</p>
	<p>Nested tabs: A set of arrows enclosed in a rectangular box denotes a set of nested cut-out tabs.</p>

Figure 11: Graphical notations of cut-out tabs.

A Restaurant Guide Example

Consider a restaurant guide that lists restaurants in a number of suburbs according to their specialty. The root (or starting) page of the restaurant guide is denoted as R, followed by the restaurant directories for m types of cuisines $D_i, i = 1, \dots, m$. Then come the suburb sections, one for each of the n listed suburbs. Each suburb section

has an overview page S_j and m cuisine sub-sections $C_{ij}, i = 1, \dots, m$, one for each of the m cuisines where $1 \leq j \leq n$. In summary, the document has the structure:

R D_1 $D_2 \dots D_m$ S_1 C_{11} $C_{21} \dots C_{m1} \dots S_n$ C_{1n} $C_{2n} \dots C_{mn}$

Defining the Hyperlinks

The hyperlinks defined are listed in table 1. Each of the hyperlinks listed in table 1 is assigned a cut-out tab. Additional hyperlinks that link each directory entry to the restaurant may be defined for the display version.

The set of cut-out tabs is initially given by:

$$H_0 = \bigcup_{i=1}^m \{RD_i\} \cup \bigcup_{\substack{r=1 \\ s \neq r}}^m \bigcup_{s=1}^m \{D_r D_s\} \cup \bigcup_{i=1}^m \bigcup_{j=1}^n \{D_i S_j\} \\ \cup \bigcup_{j=1}^n \bigcup_{i=1}^m \{S_j D_i\} \cup \bigcup_{j=1}^n \{RS_j\} \cup \bigcup_{j=1}^n \bigcup_{i=1}^m \{S_j C_{ij}\} \\ \cup \bigcup_{j=1}^n \bigcup_{\substack{r=1 \\ s \neq r}}^m \bigcup_{s=1}^m \{C_{rj} C_{sj}\} \cup \bigcup_{j=1}^n \bigcup_{i=1}^m \bigcup_{r=1}^m \{C_{rj} D_i\}$$

- a total of $n(1 + 2m + 2m^2) + m^2$ tabs.

Table 1: Hyperlinks in the Restaurant Guide Example

Hyperlinks	Description
$RD_i, i = 1, \dots, m$	from the root page to each cuisine directory
$D_r D_s, r, s = 1, \dots, m, r \neq s$	from each cuisine directory to another cuisine directory
$D_i S_j, i = 1, \dots, m, j = 1, \dots, n$	from each cuisine directory to each suburb section
$S_j D_i, i = 1, \dots, m, j = 1, \dots, n$	from each suburb section to each cuisine directory
$RS_j, j = 1, \dots, n$	from the root page to each suburb section
$S_j C_{ij}, i = 1, \dots, m, j = 1, \dots, n$	from each suburb section to each of its local cuisine sections
$C_{rj} C_{sj}, r, s = 1, \dots, m, r \neq s, j = 1, \dots, n$	from each cuisine section of a suburb to the other cuisine sections of the same suburb
$C_{rj} D_i, r, i = 1, \dots, m, j = 1, \dots, n$	from each cuisine section of a suburb to the cuisine directories

Sharing Cut-out Tabs

A cut-out tab can be used for multiple hyperlinks that end at the same page as the tab. In fact, a tab AB can potentially be used for any hyperlink that starts at A or at a section between A and B and ends at B provided that the tab is

properly labelled on all the pages it passes through and that such use is not confusing to the reader. For instance, referring to the final tab assignment in figure 12, the tab RD_m running from R to D_m is shared by hyperlinks RD_m and $D_r D_m$ where $r=1, \dots, m-1$. In addition, a tab AB leading from a page A to a page B provides an implicit return path from page B to page A. Hence, the number of tabs can be reduced by merging tab pairs that have their two tabs start on the page the other tab ends.

By sharing tabs among hyperlinks, the original set of cut-out tabs is reduced to:

$$H_1 = \bigcup_{i=1}^m \{RD_i\} \cup \bigcup_{s=1}^m \{C_{sn} D_s\} \cup \bigcup_{j=1}^n \{RS_j\} \\ \cup \bigcup_{j=1}^n \bigcup_{s=1}^m \{S_j C_{sj}\} \cup \bigcup_{j=1}^n \bigcup_{s=1}^{m-1} \{C_{mj} C_{sj}\}$$

The total number of tabs is now $2nm + 2m$.

Nesting Cut-out Tabs

Related tabs are nested to reduce the total edge space required by the tabs. A set of nested tabs should link materials that have a natural or logical relationship. Such relationship may be inferred from the structure of the document and other information provided by the author. For instance, the set of nested tabs RD_m in figure 12 are used for assessing the m restaurant directories each for a different cuisine. In this case, nesting the tabs reduces the number of axes required from m to 1.

The innermost unions of each of the terms of H_1 can be nested. Hence, after nesting the tabs, the total number of (nested) tabs becomes $2n + 3$.

Aligning Axes

The last two terms of H_1 contain two sets of non-

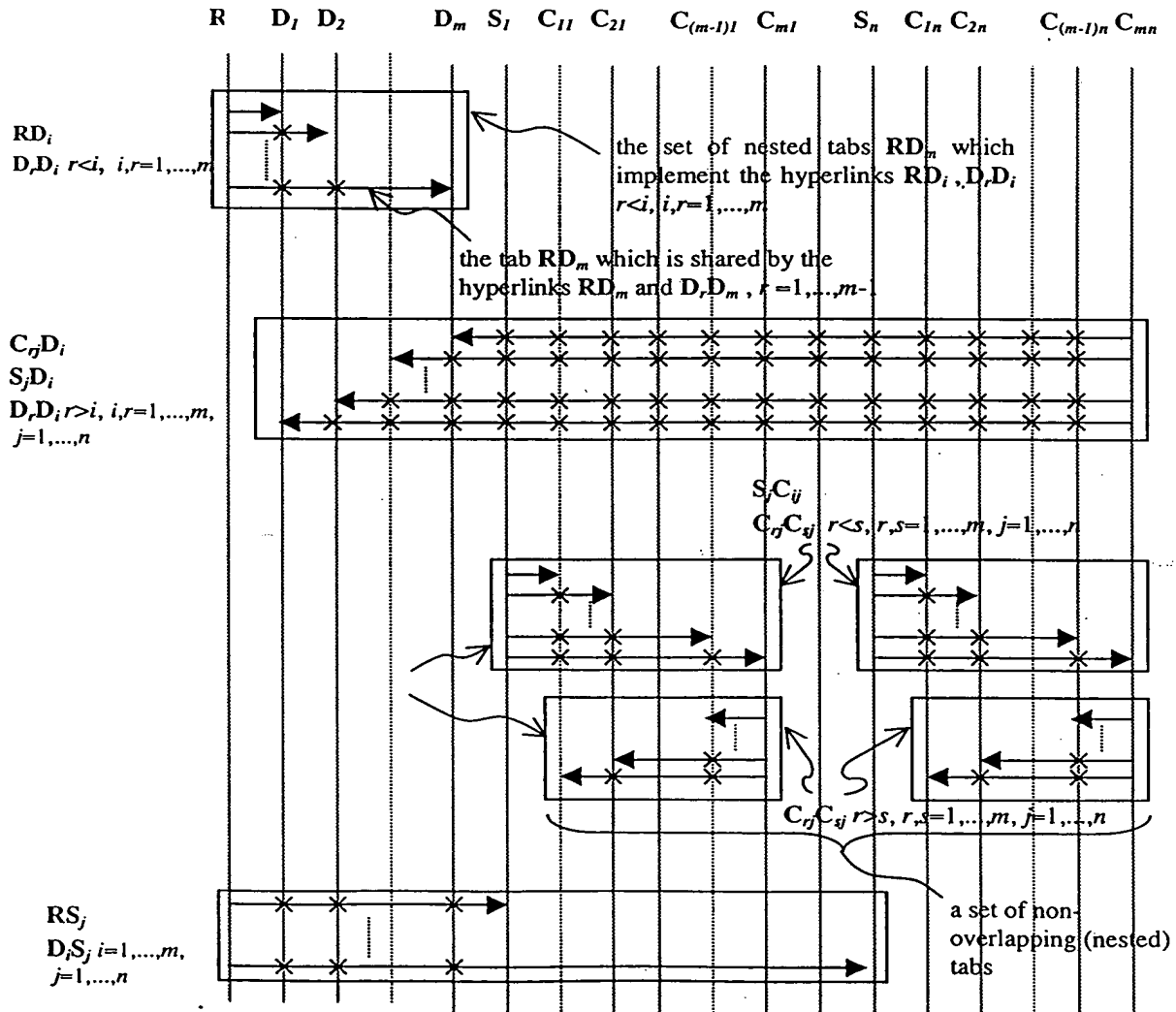


Figure 12: The final tab assignment for the restaurants guide example.

overlapping (nested) tabs $\bigcup_{j=1}^m \{C_{ij}\}, j=1, \dots, n$ and

$\bigcup_{j=1}^{m-1} \{C_{mj}, C_{ij}\}, j=1, \dots, n$. Each of the two sets can share a single axis. As a result, the $2n+3$ (nested) tabs require only 5 axes.

Some Final Remarks

It should be pointed out that we have been making the assumption that the number of suburbs n and the number of cuisine m is small enough that nesting n and m cut-out tabs is visually acceptable.

The optimization steps can be automated. However, editing tool that allows the author to adjust the resulting hyperlinks/cut-out tabs assignment interactively is desirable.

HYPERPRINT

An authoring system called Hyperprint is being developed. The system creates Web documents that can be printed and cut to support hyperlinks in their printed copies. It implements the optimization procedure we outlined in the previous section. The first prototype of the system allows the author to:

1. import a set of HTML (HyperText Markup Language) Web pages to a document
2. divide a HTML page into multiple HTML pages each printed on one side of a physical page
3. specify the tree structure of the document
4. select the hyperlinks to be physically implemented
5. optimize the hyperlinks/cut-out tab assignment
6. re-position the tabs and specify their styles
7. save the final HTML pages

The generated HTML pages can be displayed by browsers such as the Internet Explorer 4 (IE4) that support CSS1 [2] and the Document Object Model (DOM) [3]. The HTML

pages use applets for rendering the cut-out tabs. The cut-out tabs are functional both on screen and on paper. On screen, clicking the tab causes the target page to be displayed.

The parameters of the cut-out tabs are stored as Javascript variables in a "parameter" script. The "parameter" script is imported into each of the HTML pages together with a set of library scripts. Among other things, the library scripts provide a set of functions that the HTML pages may call to create HTML elements for the cut-out tabs.

IE4 can be used for printing the HTML pages of the document. At the moment, a graphics design package is used to drive a cutter and produce the cut-out tabs. The cut pages are then wire bound. A utility is being developed for printing and cutting the documents using a printer/cutter.

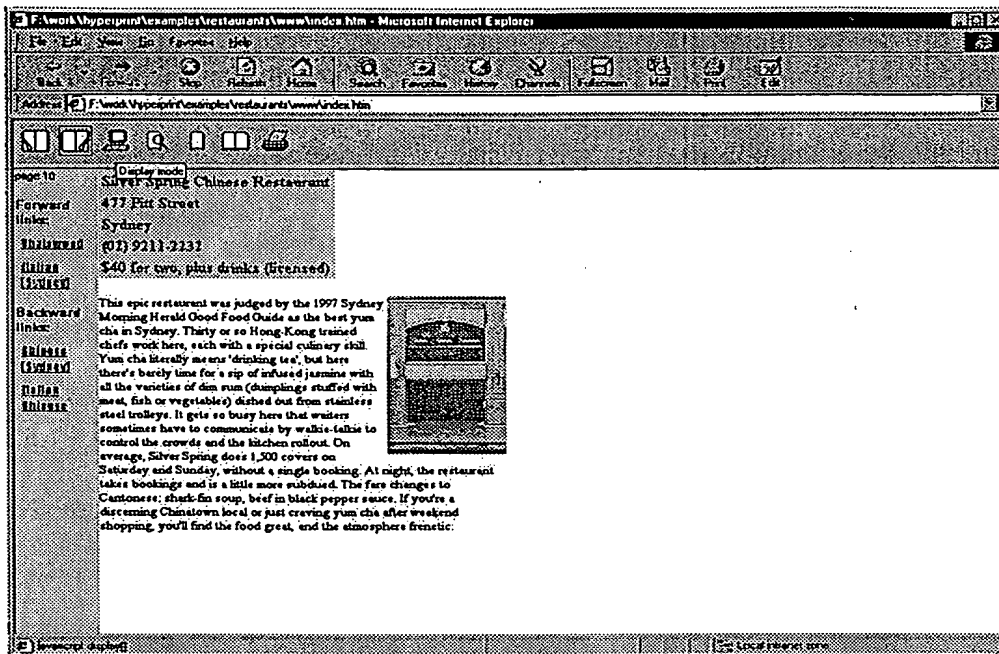
Figure 13 shows the screen output of the restaurants guide.

CONCLUSIONS

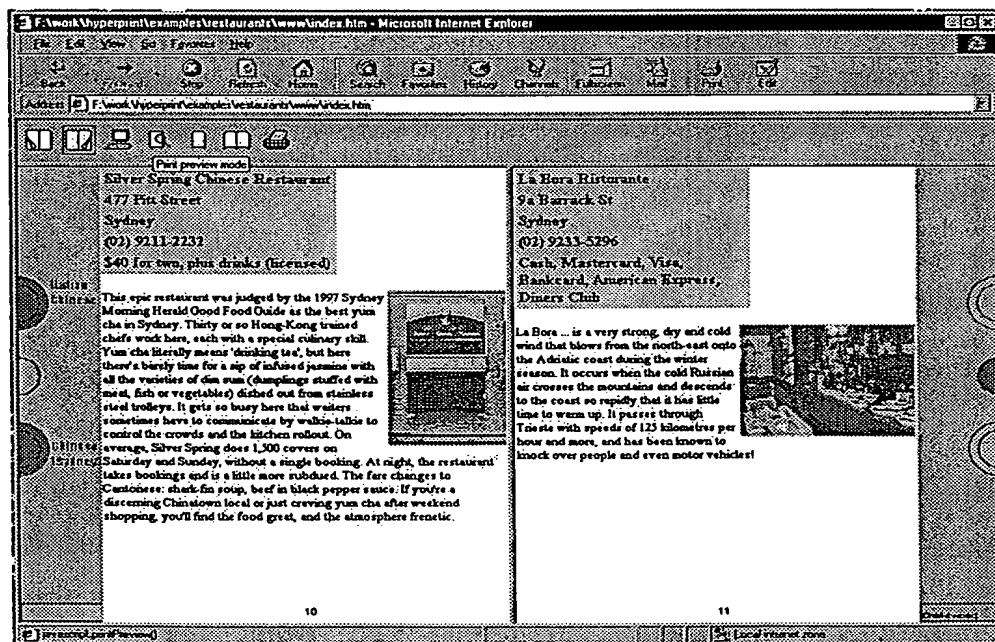
We have described a method that allows a hypermedia document to retain its hyperlinks in the printed copy. The method associates the hyperlinks with cut-out tabs on the edges of the printed pages. We discuss several presentational styles for the cut-out and their associated properties. A method for modelling the cut-out tabs and optimising their assignment to the hyperlinks was also presented. We also briefly described a prototype authoring system that we have built. The system allows an author to construct Web documents that can be printed and cut to support hyperlinks in their printed copies.

REFERENCES

1. Cascading Style Sheets Level 2 Specification. Available at <http://www.w3.org/TR/REC-CSS2/>.
2. Cascading Style Sheets Level 1 Specification. Available at <http://www.w3.org/TR/REC-CSS1-961217.html>.
3. Document Object Model Level 1 Specification. Available at <http://www.w3.org/TR/PR-DOM-Level-1/>.



(a)



(b)

Figure 13: Screen output of the restaurants guide example in (a) display mode, and (b) print preview mode.